SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE, 1926.

GENERAL PHYSICS.

1171. *Density and Atomic Weight of Helium. Part II.* **G. P. Baxter** and **H. W. Starkweather.** (Nat. Acad. Sci., Proc. 12. pp. 20–22, Jan., 1926.)—Further measurements [see Abstract 734 (1925)] with 2-litre globes give for the density of helium at 0°, 769 mm., sea-level, latitude 45°, the mean value 0·17846 and at 380 mm. pressure, 0·08923. It is evident that, by some process of compensation, helium obeys Boyle's law over the pressure range 380–760 mm. The above figures, together with the value, 1·42898, previously obtained for the density of oxygen, give for the atomic weight of helium the value 4·000, the fourth decimal figure being uncertain. T. H. P.

1172. *Recent Simplifications of the "Freiberger System" for Polygonometric Angle Measurements above Ground.* **Harbert.** (Zeits. Instrumentenk. 46. pp. 1–10, Jan., 1926.)—A description, with numerous diagrams, of modifications in the construction and application of the theodolite with a view to achieving greater accuracy in town surveying. E. F.

1173. *Electrical Method for Measuring Small Fluid Pressures.* **H. A. Thomas.** (Engineer, 141. pp. 88–89, Jan. 22, 1926.)—During investigations on air flow the need arose for a portable high-sensitivity pressure gauge with an indicating device which could be adjusted, as regards magnification ratio, whilst the gauge was in use. An equipment fulfilling these requirements is based on an electrical method used by the author for indicating small movements [Abstract 1009 (1923)]. The fluid pressures which are to be compared are applied to opposite sides of a mica diaphragm 0·004 in. thick and 3·5 in. in diameter. A thin disc of lead 1·5 in. in diameter is mounted centrally on this diaphragm and acts as the moving plate below the oscillation coil of a Hartley oscillating circuit. The oscillation coil, shunted by a tuning condenser, is connected between the grid and plate of a three-electrode valve. The general characteristics of the circuit, and typical characteristic curves obtained under stated conditions, are given in the original. The anode current varies with the distance between the metallic plate and the oscillation coil, and a micrometer attachment is provided so that the coil can be brought near the sensitive point, *i.e.* so that the apparatus works on the steep part of the characteristic curve. The sensitivity is shown to be independent of the oscillation frequency. According to the accuracy required, a pointer-type micro-ammeter or a reflecting galvanometer is used. In a particular case, with a galvanometer of sensitivity 1 m. at 1 m. per micro-amp., 1 cm. deflection corresponds to $0\cdot544 \times 10^{-7}$ in. displacement of the centre of the diaphragm, which displacement corresponds to a pressure change of $2\cdot86 \times 10^{-6}$ in. of water. R. E. N.

1174. *An Automatic Device for Focussing the Telescope of a Tacheometer.* **H. Kourkène.** (Journ. Sci. Instruments, 3. pp. 106–109, Jan., 1926.)—The device has been designed with the object of enabling the telescope of a tacheometer to be focused automatically for varying distances, as the spacing of the webs of the graticule is adjusted to suit such variations, when the telescope is used to measure distances by the stadia method. AUTHOR.

1175. *The Aspiration Psychrometer.* **H. Ebert.** (Zeits. f. Physik, 35. 8–9. pp. 689–696, 1926.)—The derivation of Sprung's formula for the aspirated psychrometer is dealt with, and next the basis employed by Gramberg in compiling his humidity tables for various dry bulb temperatures and differences of the dry and wet bulb. The calculations are carried through for a total pressure of 760 mm. Hg, for a partial air-pressure of 760 mm. and for a total pressure of 355 mm. R. S. R.

1176. *A Low-speed Vane Anemometer.* **E. Ower.** (Journ. Sci. Instruments, 3. pp. 109–112, Jan., 1926.)—A description of a carefully constructed rotating vane anemometer suitable for measuring wind speeds down to 0·5 ft. per sec. A mathematical study is made of the effect on the calibration of variations in the air density, and it is shown that if an accuracy within about 5 % is desired the effect of variation in density becomes appreciable. E. G.

1177. *An Improved All-Metal Mercury-Vapour Pump.* **G. W. C. Kaye.** (Phil. Mag. 1. pp. 349–353, Feb., 1926.)—An all-metal vacuum pump of the condensation type has been previously described by Backhurst and Kaye [Abstracts 1991 and 1992 (1924)]. The present paper gives in detail the construction of a similar but simpler pump. A noticeable feature are the metal-to-metal joints, so obviating the use of wax seals. The mercury is heated electrically or by gas, and the tube body is water-cooled. Very full details are given, together with a sectional drawing of the pump and of a micrometer needle gauge. B. J. L.

1178. *A Combined X-Ray Tube and Vacuum Pump Unit.* **G. W. C. Kaye.** (Brit. J. of Radiology, 22. pp. 23–30; Disc., 30, Jan., 1926.)—Largely this paper is similar to that referred to in the preceding Abstract. It gives details of an all-metal vacuum pump. In this instance the pump is shown forming a single unit with a glass X-ray tube in which the gas-pressure is regulated at will by means of a needle gauge. The apparatus shown is not capable of rotation, owing to the pump operating only in the vertical position. It is suggested that this difficulty can be overcome by the use of vacuum-tight flexible metal tubing between pump and tube. B. J. L.

1179. *A Mechanical Apparatus for Tracing Hydrodynamic Fields.* **E. G. Barrillon.** (Comptes Rendus, 182. pp. 572–573, March 1, 1926.)—With six rods of length L and six of length *l*, two Peaucellier cells are constructed. By connecting the two poles on a common axis O and two nodes of two rods on another P, we get a linkage in which these two points and the remaining nodes of two rods A and B are collinear. If we put O at the origin of coordinates, and if x and y are the coordinates of P, and X is the abscissa of A, and Y the ordinate of B, we have $Z = z + \frac{k^2}{z}$, where $z = x + \iota y$, $Z = X + \iota Y$, and $k^2 = L^2 - l^2$. The point Z can be traced for motions of P by connecting bars, fixed at right angles and constrained to remain parallel to the coordinate axes, to A and B by sliders. If P traces a series of parallel lines, Z will trace the stream-lines due to flow past a circular obstacle. By the use of these stream-lines with a new origin and different values of L and *l* the stream-lines for flow round a wing section as obtained by Joukowski may be traced.
W. G. B.

1180. *On the Storage of Small Quantities of Gas at Low Pressures.* **J. J. Manley.** (Phys. Soc., Proc. 38. pp. 129–131, Feb., 1926.)—The author describes and gives a figure of an apparatus used for storing small quantities of rare or highly purified gases in such a way that contaminating air is excluded. The apparatus is designed for use in conjunction with a Sprengel pump, which withdraws the gas from any experimental plant and delivers it into the storage apparatus. With the aid of barometric traps, etc., the gas can be readmitted either partically or wholly into the experimental plant.
Author.

1181. *A New Sorption Balance.* **J. W. McBain** and **A. M. Bakr.** (Am. Chem. Soc., J. 48. pp. 690–695, March, 1926.)—An apparatus is described for measurement of the weight of vapour adsorbed on a sample of charcoal over a wide range of temperature, without exposure of the charcoal to any possible source of contamination during a complete series of experiments. It comprises a fine, calibrated silica spring on which depends a platinum or gold bucket to hold the adsorbing material. The spring is supported in a long glass tube which can be evacuated, and the upper part of which can be heated to 450° C. The liquid whose vapour is to be adsorbed is introduced in a small glass bulb placed at the bottom of the tube. After evacuation to free the adsorbing material from gas, the apparatus is sealed off and the bottom part is cooled in liquid air; the glass bulb is then broken, and, after removal from the cooling agent, the amount of vapour adsorbed is determined from the extension of the spring. The upper part of the apparatus is enclosed in a thermostat at whatever temperature it may be desired to measure the adsorption, while the pressure of the vapour in contact with the adsorbent is regulated by placing the lower end of the tube in a second thermostat.
L. M. C.

1182. *A New Type of Flowmeter.* **J. H. Powell.** (Journ. Sci. Instruments, 3. pp. 144–148, Feb., 1926.)—A form of flowmeter is described in which a loosely fitting piston of neutral bouyancy is impelled along a glass tube by the flow of the liquid, against a spring control in which the restoring force is proportional to the square of the displacement, so as to obtain an approximately even velocity scale. The movements of the piston are recorded on a photographic drum nearly touching the tube by filling a groove in the piston with radium luminous compound.

AUTHOR.

1183. *The Sixteenth Annual Exhibition of Scientific Instruments.* (Journ. Sci. Instruments, 3. pp. 148–170, Feb., 1926.)—A review of some of the instruments exhibited, classified under (1) Electrical, (2) Optical and (3) Research.

1184. *Air-bubble Viscometer.* **G. Barr.** (Phil. Mag. 1. pp. 395–405, Feb., 1926.)—This is an investigation as to how far the rate of rise of a large bubble in a vertical tube containing liquid can be taken as an indication of the viscosity of the liquid. The effects of length of bubble and diameter of tube have been examined and the rate of rise determined for several oils of known viscosity and surface-tension, for water and for glycerine. Above a certain limit the length of bubble is without appreciable effect. For bubbles rising slowly it has been found that the rate of rise is inversely proportional to the kinematic viscosity, provided that the surface tension is constant. An approximate determination has been made of the form of the function of r/a, upon which, in addition to the viscosity, the rate of rise depends. It is concluded that the viscometer may be used for the approximate comparison of viscosities of materials of the same class, and a simple modification is suggested to enable a check to be made upon the assumed constancy of surface-tension. F. S.

1185. *Preparation and Technical Uses of Synthetic Gems.* **A. Werner.** (Zeits. Instrumentenk. 45. pp. 579–585, Dec., 1925.)—The author discusses briefly the differences between the classification used in mineralogy and that used in trade, and outlines early attempts at the production of synthetic rubies. He describes in detail the apparatus and process of Verneuil and Paquier, in which finely-powdered aluminium oxide containing 2·5 % of chromium oxide is sprinkled through an oxyhydrogen flame and collects in a molten condition on a surface on which the flame impinges. A crystalline body is thus gradually built up. This process is capable of producing rubies up to 80 carats at the rate of 10 carats an hour. Reference is made to later improvements in the process and to the impossibility of distinguishing the artificial from the natural gems. Blue sapphires of all varieties are also produced artificially in commercial size and quantity. Up to the present, however, turquoises have not been successfully prepared. Emeralds, like diamonds, have been made artificially, but only of such small sizes as to be of no practical value. At the present day the jewels used in watches and fine measuring instruments, etc., are almost exclusively artificial rubies and sapphires. The author describes the shapes used for different purposes and how they are cut, ground and drilled. W. H. G.

1186. *The Non-metallic Elements: their Dielectric and other Physical Properties. Part II.* **G. L. Addenbrooke.** (Phil. Mag. 1. pp. 225–243, Jan., 1926.)—In a previous paper [see Abstract 1979 (1924)] relations were shown to exist between the dielectric properties of ten non-metallic elements and their thermal properties, surface-tension and capillarity. The present investigation relates to some gaseous elements (hydrogen, helium, oxygen, nitrogen), and applies similar methods and reasoning to those employed in Part I. Comparisons of absolute electrical properties in gaseous, liquid and solid states are made. It is found that, to a close approximation, there is little change, not only in the relative values, but also in the atomic values of the energy stored and the corresponding attractions for a given number of atoms of these gases in an electric field of the same slope, for the gaseous and for the liquid state. The results are extended to other elements. From a discussion of electrical and optical formulæ it is concluded, in cases where K and N^2 are found in substantial agreement, that a close connection exists between the attractive forces at the frequencies of light and the energy stored under the action of these forces, and is fairly expressed by $(N^2 - 1)/(N^2 + 2)$, as that between attraction and energy stored is by $(K - 1)/(K + 1)$ for ordinary electric fields; the formulæ are connected by the fact that $K = N^2$ substantially for the elements concerned. The real nature of Faraday's "specific inductive capacity" (dielectric constant) is discussed and a fairly comprehensive view given of what occurs to dielectric matter when placed in ordinary electric fields. The paper concludes with discussions on the effects of aggregation on atoms and on the nature of absorption, electrical and optical. The opinion is expressed that no fundamental difference exists between what are called dielectrics and ordinary electrolytic solutions of all kinds. H. H. Ho.

1187. *The Physical Properties of Glass in Relation to its Composition. Part II. The Mechanical Properties of Glass.* **G. Gehlhoff** and **M. Thomas.** (Zeits. techn. Physik, 7. 3. pp. 105–126, 1926.)—A continuation of [Abstract 162 (1926)] recording work in the Osram Technical Laboratory. The present paper contains experimental details, description and illustration of apparatus used and numerical results obtained for the density, ductility, bending, compressibility, resistance to fracture, hardness and modulus of elasticity, etc. The precise influence of the introduction of different proportions of various oxides into the glass composition is recorded in curves and tables. A final comparison is made in a summary table of all the results, and the whole is related to Winklemann and Schott's formula for the coefficient of thermal resistance

$$F = \frac{P}{\alpha E}\sqrt{\frac{K}{S.C.}}$$

The ductility and bending are in close relationship to each other, but the ductility and compressibility show no proportionality. Alkalies have a strong influence, and K_2O and Na_2O present affect the characteristics similarly. The hardness tests for many different proportions of the two above alkalies are recorded, together with the results for CaO, BaO and PbO. It is shown that for all boric acid glasses the various characteristics, with the exception of the compressibility, are at a maximum if the glass contains 15 % B_2O_3. S. G. B.

1188. *Passage of Hydrogen Gas through Nickel.* **V. Lombard.** (Comptes Rendus, 182. pp. 463–464, Feb. 15, 1926.)—Further experiments have verified results already given [Abstract 153 (1924)]. The effects of the pressure of the gas and of the thickness of the metal are shown by means of curves relating to temperatures round about 500° C. The permeability of the metal can be related to the thickness, *h*, by means of a function of the form K/d^a, where K and a are constants for a given temperature. This result does not agree with that given by other authors. [See Abstract 1306 (1924).] G. E. A.

1189. *Rate of Flow of Various Gases through a Porous Wall.* **J. Sameshima.** (Chem. Soc. Japan, Bull. 1. pp. 5–8, Jan., 1926.)—Experimental determinations of the rate of flow of CH_4, NH_3, C_2H_2, C_2H_4, CO_2, O_2 and air, respectively, at various pressures, through a disc of compact unglazed earthenware show that the formula $t = k\sqrt{M}$ for the velocity of effusion of gases through a thin perforated plate is inapplicable. The equation $t = k\eta^n M^{(1-n)/2}$, where t = time of effusion, η = viscosity coefficient, M = molecular weight, k and n being constants independent of the kind of gas, but dependent on the nature of the diaphragm and on the pressure, is found to be in close agreement with the results obtained. A. B. C. L.

1190. *Elimination of Salt from Sea-water Ice.* **W. G. Whitman.** (Am. J. Sci. 11. pp. 126–132, Feb., 1926.)—Experiment shows that ice containing entrapped salt will expel this salt under the influence of a temperature gradient throughout the ice. The salt diffuses in the form of brine towards the warmest part of the ice cake. Diffusion will not occur where the temperature of the ice is below the eutectic temperature, − 21° C. The process of diffusion is independent of gravity and is explained satisfactorily by the effect of temperature and by the equilibrium relationships between ice and salt solutions. These results show why the saltiness of ice which has floated in the ocean during a warm season has decreased sufficiently to render the ice potable although brackish, and why ice that has been floating during two or three seasons contains less salt than ordinary river waters. T. H. P.

1191. *Stroboscopic Measurements.* **H. E. Linckh** and **R. Vieweg.** (Zeits. Instrumentenk. 46. pp. 30–40, Jan., 1926.)—The paper commences with a brief description of various stroboscopic methods in use. Following this the different instruments are considered under two groups: (1) Single disc processes based on a rotating disc and a non-rotating means of observation, *viz.* an intermittent light source or a mechanically oscillating system. (2) Two-disc processes. General relationships are established between the number of observed images, the number of rotations, the frequency of the auxiliary employed, and the various instrument constants involved. General formulæ are then derived applicable to the ordinary cases which arise in practice. The paper is illustrated by many photographs, and should be consulted in its entirety. H. H. Ho.

1192. *On Stroboscopic Observations.* **H. E. Linckh** and **R. Vieweg.** (Archiv f. Elektrot. 15. pp. 509–521, Feb. 22, 1926. From the Reichsanstalt.)—This paper contains a very complete account of stroboscopic processes and supplements a previous publication by the same authors [see preceding Abstract]. In the introduction a survey of the field is made and the various processes divided into two main groups, *viz.* those involving two-disc and single-disc instruments respectively. Illustrative diagrams are included. The mathematical treatment is more comprehensive than in the previous paper (*loc. cit.*), and from relations between the number of images observed and the various instrument constants formulæ are derived which hold good generally. The latter in turn may be used for calibration purposes. The paper should be consulted in its entirety owing to its detailed character. H. H. Ho.

1193. *The Effect of Temperature on the Viscosity of Air.* **F. A. Williams.** (Roy. Soc., Proc. 110. pp. 141–167, Jan. 1, 1926.)—Determination of the coefficient of viscosity of dry air free from carbon dioxide by means of a comparative method of transpiration at temperatures from 15° – 1002° C. show that Sutherland's formula for the temperature coefficient of viscosity holds with great accuracy between 250° and 1000° C. or $n\alpha T^{\frac{1}{2}}/(1 + C/T)$, where C is found to have the value 172·6. Below 250° C. the value of C falls off as the temperature decreases, and Sutherland's law is no longer true. J. N. P.

1194. *On the Internal Friction (Viscosity) of Certain Metals.* **F. Hettwer.** (Akad. Wiss. Wien, Ber. 134. 2a. No. 1–2. pp. 51–67, 1925.)—The paper commences with an exhaustive *résumé* of previous work in this field and includes a complete list of the relevant literature. The earlier interpretations were based on dynamical data, and only later were statical methods introduced. A discussion is then given of methods for the evaluation of viscosity coefficients, from which the author deduces the possibility of arriving at absolute data by a torsion method. Full apparatus and manipulative details of such a method are then given, followed by a description of the materials employed. The values found for the viscosity coefficients n are: lead ($4{\cdot}7 \times 10^{14}$), tin ($2{\cdot}4 \times 10^{15}$), aluminium ($7{\cdot}5 \times 10^{15}$), and zinc ($3{\cdot}2 \times 10^{16}$). The viscosities of the alloys of lead and tin are then discussed on account of singularities in their thermodynamic behaviour, and the conclusion is drawn from the experimental data obtained that these values are appreciably higher than those of their components, although further experiments are deemed necessary. H. H. Ho.

1195. *Kinetic Theory of Surface Films. Part II. Gaseous, Expanded and Condensed Films.* **R. K. Schofield** and **E. K. Rideal.** (Roy. Soc., Proc. 110. pp. 167–177, Jan. 1, 1926.)—In order to test Langmuir's view that surface films of the long-chain fatty acids resemble liquids, and to ascertain the origin of F, the outward force which they exert, curves connecting FA/RT and F′ for surface films of the sparingly soluble fatty acids C_8, C_{10} and C_{12} have been constructed [see Abstract 2412 (1925)] from Frumkin's surface-tension-concentration data. The curves for C_8 and C_{10} acids closely resemble the curves connecting pv/RT and p' for gases at successively lower temperatures than with the films of the more soluble C_4 and C_6 acids. That for the C_{12} acid is essentially similar to the corresponding curve for the insoluble C_{14} acid, and both of these films resemble liquids just below their critical temperature, that for C_{12} showing a surface vapour-pressure of slightly over 0·2 dynes per cm. At high surface pressures the curves are straight, and thus obey the relation $F(A - B) = x\mathrm{RT}$ analogous to Amagat's equation for highly compressed gases and liquids. In each case B has the value 24 to 25 A.U. per molecule, previously found for the C_4, C_6 and C_8 acids, further support being thus furnished to Langmuir's view that, under high compression, the molecules in these films are vertically orientated.

The value of x decreases steadily with increase in the length of the hydrocarbon chain, indicating increasing lateral cohesion. At low surface pressure the films behave approximately but not exactly like liquids. Although the outward force exerted by expanded as well as gaseous films is essentially kinetic in origin, this is probably not true of condensed films. T. H. P.

1196. *Films of Adhesives.* **J. W. McBain and D. G. Hopkins.** (J. Phys. Chem. 30. pp. 114–125, Jan., 1926.)—Measurements are made of the breaking strength of thin films of adhesive which are formed by allowing them to dry on a surface to which they will not adhere. The tensile strength of such films, which with gelatin and glue exceeds 5 tons/in.^{2}, is greater than that of any wooden join and is equalled only by the end grain strength of the strongest wood. The addition of powdered solids lead to a weakening of the films, while of the soluble substances tried, potassium bichromate alone increases the tenacity. Potassium alum, sodium benzoate, sodium formate, sodium salicylate and glucose reduce the tensile strength. Films prepared from 25 % solutions of glue in water or in N/10 hydrochloric acid are equally tenacious, whereas films from glue dissolved in N/10 sodium hydroxide are decidedly weaker. The hydrolytic degradation of such aqueous, acid and alkaline solutions of glue continuously heated causes a relatively slight loss of tensile strength even after twenty-eight days' heating at 55°–57° C., but the effect is much greater at higher temperatures, and the films, even when of high tensile strength, become extremely brittle. [See Abstract 1297 (1925).] J. N. P.

1197. *Phenomena occurring at the Surface of Bubbles in Water.* **T. Alty.** (Roy. Soc., Proc. 110. pp. 178–190, Jan. 1, 1926.)—By means of the drop-weight method, comparison is made between the values of the surface-tension of water in contact with different gases [see Abstract 242 (1925)]. If the rate of flow of the gas is slow enough, the weight of a bubble is independent of the nature of the gas. If it is required to examine a new water surface, the rate of flow of the gas is increased until several bubbles emerge per second. When the necessary corrections are made, it is found that the volume of the bubble depends on the character of the gas, being relatively great for inert gases and smaller for chemically active gases.

When flowing from the same capillary, the gases form bubbles with volumes arranged in the following order of decreasing magnitude: A, N_2, O_2, O_3, H_2, NO, CO_2, the differences being related to the adsorbabilities of the different gases. T. H. P.

1198. *The Spreading of One Liquid on the Surface of Another.* **R. S. Burdon.** (Phys. Soc., Proc. 38. pp. 148–159; Disc., 159–160, Feb., 1926.)—The spreading of liquid films on the surface of mercury is described with photographs. A drop of distilled water spreads slowly, retaining its circular form; tap-water spreads much more quickly—the purer the water, the slower the spreading. Acid or neutral salt (even CO_2 dissolved from the air) accelerates spreading, but alkali (even a small percentage of NH_3 in the air) prevents it. A drop of very dilute acid spreads quickly to cover a definite area, subsequent spreading then taking place as slowly as with pure water. The area covered in the rapid stage is proportional to the number of acid molecules, but is much greater than that necessary for a monomolecular layer of the corresponding salt. Placing a platinum wire from one terminal of a battery in the mercury and the other in the drop causes even alkalies to spread if the mercury be positive, but prevents the spreading of acids if the mercury be negative. W. G. B.

1199. *Structure of Thin Films. Part VII. Critical Evaporation Phenomena at Low Compressions.* **N. K. Adam** and **G. Jessop.** (Roy. Soc., Proc. 110. pp. 423–441, Feb. 1, 1926.)—Modifications are introduced into the apparatus previously employed [see Abstract 998 (1925)] with a view to avoiding the possibility of errors suspected to affect the reality of the lowest portions of the compression-area curves obtained, and an improvement, of about fifty times, is made on the sensitivity of the previous apparatus. Measurements of the surface pressure of monomolecular films are made at room-temperature down to 0·01 dyne/cm. At areas greater than about 5000 square Å.U. per mol. the pressures exerted by films of insoluble fatty substances tend within the limits of experimental error, to a value given by the equation $F\alpha = RT$, R having the same value as in a perfect gas. Between 100 and 5000 square Å.U. the pressure-area isothermals closely resemble those for liquid and vapour in three dimensions. With longer chains in the molecule there is a horizontal " vapour-pressure " region, ending on the one hand in an imperfect gaseous film, on the other in either the condensed or the expanded type of film. When the chains are shorter, a condition corresponding to a higher temperature, the " vapour-pressure " region disappears, and the films are above their critical point. Expanded films are analogous to liquids, not vapours, and there is considerable cohesion between their molecules. The heats of two dimensional evaporation from expanded to gaseous films are of the same order of magnitude as the heats of spreading, from bulk to a condensed film, on a water surface. The evidence, though incomplete, indicates loss of orientation in expanded films. A. B. C. L.

1200. *Spreading of Solids on Water Surfaces.* **N. K. Adam** and **G. Jessop.** (Roy. Soc., Proc. 110. pp. 441–443, Feb. 1, 1926.)—Advantage is taken of the improved apparatus designed to give greater sensitivity at low compression [see preceding Abstract] to continue the observations by Cary and Rideal [see Abstract 400 (1926)] on the spreading of myristic acid on water down to very low compressions. A small pressure—that of the gaseous state of the films—is set up within a few seconds after the crystal touches the surface, and the " two-dimensional vapour-pressure " very soon afterwards. A. B. C. L.

1201. *Hardening under Tension and Compression.* **W. Tafel.** (Ann. d. Physik, 78. 5. pp. 465–497, Dec., 1925.)—Discusses various theories of the cause of the hardening effect of overstrain in tension and compression, and advances a theory of the author's according to which the hardening arises from internal or secondary stresses, the latter being set up between the inner core and the exterior layers of the specimen. The internal compressive stresses are considered mainly responsible for the hardening effect; in the case of tension specimens these occur mainly in the skin of the test-piece, while in compressive specimens they occur chiefly in the core. Experiments are described in which sand and lead shot, both dry and wet, and iron filings are used to represent various conditions of the particles in a strained body, the hardness under various degrees of compression being measured by a modified Brinell test. The results of these experiments support the assumptions underlying the author's theory. Further experiments are necessary to test the theory as regards tension. C. B. C.

1202. *Cohesive Strength of Rock-salt.* **A. Joffé** and **M. Lewitsky.** (Zeits. f. Physik, 35. 6. pp. 442–445, 1926.)—A sphere of rock-salt, heated suddenly from — 180° to 100° or 600° C., withstood the resulting tensile stress of from 25–70 kg./sq. mm. at its centre without fracture. It follows that the tensile strength of rock-salt is of the order of magnitude of the theoretical cohesive strength. [See Abstract 1298 (1925).] J. S. G. T.

1203. *The Bending of Rock-salt in Air and Water.* **Marie Lewitsky.** (Zeits. f. Physik, 35. 11–12. pp. 850–862, 1926.)—The elastic limit of rock-salt determined röntgenographically is found not to coincide with the elastic limit *f* as ordinarily determined mechanically, but coincides with the limit *f′* indicating the incidence of flow in the crystal. There is no appreciable distension of the Laue diagram of the crystal between the limits *f* and *f′*. The value of the elastic limit *f* of rock-salt at room-temperature is 720 g./sq. mm., whilst the elastic modulus E at the same temperature is 4179 kg./sq. mm. The corresponding values of *f* and E at 300° C. are 400 g./sq. mm. and 3380 kg./sq. mm. The values of *f* and E are unchanged in water and sodium chloride solutions. Flow in rock-salt crystals in water begins just after the elastic limit has been passed. The plasticity of rock-salt in water is attributable to the larger value of the permanent deformation and the increased tenacity. It is suggested that permanent deformation between the limits *f* and *f′* consists principally of a pure translatory displacement, and that the limit *f′* represents the commencement of destruction of the crystal lattice, which is dependent entirely upon molecular forces within the rock-salt crystal. J. S. G. T.

1204. *On the Plasticity of Amorphous and Crystalline Solids.* **R. Becker.** (Phys. Zeits. 26. pp. 919–925, Dec. 31, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—In this paper the author seeks to explain the whole province of the plastic deformability of solid bodies by means of the three basic phenomena of positional alteration, tension variation and solidity. The molecular positional change is shown to determine the plasticity of amorphous bodies and to enable the deduction of a quantitative connection between viscosity and diffusion whose experimental substantiation, however, remains to be carried out. For crystalline bodies positional change is of great significance, while the flow velocity may be determined by spontaneous variations of tension. The existence of the temperature dependence of plasticity, derived from theoretical considerations, has been established at last by experiments on tungsten. The proof has been rendered difficult by the tenacity of materials, which property hitherto has obscured the very slight temperature sensitiveness of crystalline substances with respect to their plastic properties. All three of these fundamental phenomena simultaneously appear during the viscous flow of metals above their recrystallisation temperature. In the *Discussion,* **Smekal** refers to an extremely sensitive apparatus for measuring small expansions of the order of 10^{-7} cm. designed by Handford. H. H. Ho.

1205. *Concentration of Stress in the Neighbourhood of a Small Spherical Flaw, and the Propagation of Fatigue Fractures in "Statistically Isotropic" Materials.* **R. V. Southwell and H. J. Gough.** (Phil. Mag. 1. pp. 71–97, Jan., 1926.)—The present paper has been written to summarise the position now attained in this field of activity. Part I deals with the propagation of fatigue fractures in the following sections: Stress-concentration produced by a small spherical flaw in material subjected to uniform tension; extension to compound stress-systems; effect of a small spherical flaw in a twisted shaft; propagation of a crack in a twisted shaft. Part II deals with the origin of fatigue fractures as follows: Application of the theory to laboratory tests; effects of initial straining. It is found that a flaw in statistically isotropic material inevitably results in the helicoidal type of fracture under alternating torsional stresses, and this fact should serve as an indicator of the existence or otherwise of flaws. In cast iron, which fractures along a helicoidal surface even when tested under static torsion, flaws must be present initially, which, due to the low ductility of the iron, produce local concentrations of stress, resulting in rupture of the material. No other metal appears to behave in this way. The direction followed by a fatigue fracture in a laboratory test of undrilled material is influenced by two factors—the tendency of a crack to intensify stress, and the tendency of slipping on any surface of the material to make this a direction of special weakness. The former causes development along surfaces of maximum tension; the latter makes the crack follow surfaces of maximum shear. The paper is replete with data, illustrations, and special discussions, which latter require the original to be consulted. H. H. Ho.

1206. *Stresses resulting from Unequal Heating of an Isotropic Sphere.* **G. Grünberg.** (Zeits. f. Physik, 35. 7. pp. 548–555, 1926.)—The paper is a mathematical investigation of stress distribution in an isotropic sphere heated externally. The radial stress S_r has always its maximum at the centre of the sphere, rising from zero at time zero to a maximum value after a time $t_0 = 0{\cdot}0574\ R^2/a^2$, where R is the radius of the sphere and a the constant of $\frac{\partial(rT)}{\partial t} = a^2\frac{\partial^2(rT)}{\partial r^2}$. In the case of S_t, the tangential stress, it is equal to S_r at the centre and decreases with distance from it, being negative at the centre. The maximum value of S_t occurs at a time $t = 0$. The maximum values of S_r and S_t are independent of the size of the sphere and of a^2, but proportional to the original temperature difference between the sphere and the medium into which it is regarded as being suddenly plunged. W. V. M.

1207. *Laws of Failure of Solid Bodies due to Stress.* **C. Sunatani.** (Tôhoku Univ., Technol. Reports, 5. 4. pp. 55–83, 1925.)—A mathematical investigation of the laws of failure of aelotropic bodies under stress, showing that the laws may be determined by graphical methods, using Mohr's diagram, more conveniently than by algebraic methods. It is also shown that the case of isotropic bodies can be more simply dealt with by the

Mohr diagram than by algebraic methods. The article cannot be abstracted. C. B. C.

1208. *Experimental Determination of the Distribution of Stress across the Walls of Thick Cylinders subjected to Internal Pressures.* **H. E. L. Martin.** (Univ. of Durham Phil. Soc., Proc. 7. 2. pp. 79–89, 1924–1925.)—This paper investigates the distribution of stress from point to point across the walls of thick cylinders, previous strain measurements having been made at the outer radius only [see Abstract 124 (1912)], and compares the experimental results with Lamé's theorem. It is found that the equations derived from the latter theorem hold so long as the material at the radius considered is not strained beyond the range of linear proportionality. It is pointed out, however, that the increase in the external diameter is dependent upon the over-stressed material as well as upon that not over-stressed. The data at present available suggest that the law in this region is of the form: $p + q = a - b/r^2 + c/r^4$, etc., where a, b and c are constants. H. H. Ho.

1209. *On the Rate of Deformation of Metals at High Temperatures.* **P. Henry.** (Comptes Rendus, 182. pp. 761–762, March 22, 1926.)—From a study of the torsion of metallic cylinders the author has deduced a simple relation connecting the three variables, couple P, temperature T, and rate of torsion w [see also Abstract 1186 (1921)], *viz.* $P = K(K_1 + K_2 \log w - T)/(T - A)$, where K is a constant depending on the units, and K_1, K_2 and A are constants depending only on the nature of the metal. Experimental data will follow later. H. H. Ho.

1210. *The Torsion of a Hollow Cylinder whose Right Section is bounded by Two Eccentric Circles.* **B. Grinberg** and **M. Paschoud.** (Comptes Rendus, 182. pp. 759–761, March 22, 1926.)—Boussinesq has shown that this problem is similar to that of stationary temperatures in a hollow cylinder when homogeneous and isotropic—a problem which has been treated generally by Lamé in his "Leçons sur les coordonnées curvilignes." The present authors now use Lamé's bicircular coordinates to investigate the case where the section of the cylinder is bounded by two eccentric circles. The paper is entirely mathematical. **Errata** (*ibid.*, p. 896, April 7, 1926.) H. H. Ho.

1211. *Determination of Young's Modulus from Compression Tests on Circular Cylinders.* **F. E. Relton.** (Phil. Mag. 1. pp. 463–481, Feb., 1926.)—The present investigation attempts to explain certain anomalies in the behaviour of specimens under compressive loads, since the compression test, as usually carried out, does not necessarily give the true value of Young's modulus, despite modern experimental refinement. The author has made use of previous work by Filon and Dougall [see Abstract 391 (1915)]. In Filon's work the analysis is limited by the assumption that no movement takes place at the periphery of the end face of the test piece, a correction for any such movement being subsequently made. The analysis now presented obviates this difficulty. The subject-matter is considered under three sections: (1) An application of the mathematical theory of elasticity to the behaviour of short cylinders in compression to find why plane sections do not necessarily remain plane after loading; (2) determination of the conditions requisite for a correct evaluation of Young's modulus and Poisson's ratio; (3) search for a method of determining Young's modulus when the conditions in (2) are violated. It is shown that when the displacements are symmetrical about an axis, the strains and principal stresses are all expressible in terms of a single function which satisfies a partial differential equation of the fourth order. Of the infinite number of solutions to the latter equation two types are chosen: (1) Solutions involving circular and Bessel functions; (2) a finite polynomial. From these a solution is formed by multiplying them by constants and combining them additively. This solution is then made to fit the requisite boundary conditions, thereby establishing certain relations among the constants which by suitable choice are made adequate for the solution of the problem. The contraction of a known length and the extension of a diameter of the mid-section are computed. It is found that the accurate determination of Young's modulus is indissolubly bound up with Poisson's ratio.

H. H. Ho.

1212. *The Vibrations of Rods and Shafts with Tension or End-thrust.* **R. C. J. Howland.** (Phil. Mag. 1. pp. 674–694, March, 1926.)—For a rod or shaft without end-thrust or tension, a method for reducing the integration to a series of quadratures was given by Cowley and Levy [see Abstract 1196 (1921)], which solves the equation in a series in powers of a parameter which is a multiple of the square of the whirling speed or of the frequency. A special application of this method has been made by the present author [see Abstract 1801 (1925)] to determine the whirling speeds of a shaft carrying concentrated masses, and the same method is now applied to the more general problem of a rod or shaft under axial force. By the assumption of a double series in powers of two parameters a solution is found which, involving only quadratures, is suitable for graphical or numerical calculation. The method is illustrated by applying it to a uniform shaft, and the results are compared with those given by an exact integration. An application to rods and shafts carrying concentrated masses is then made, and the error in Dunkerley's rule calculated for a number of different end-thrusts and tensions. The method is both vigorous and general, and from a review of previous work appears to be the first attempt at dealing with the general problem. The paper is mathematical throughout, and establishes that the error in Dunkerley's rule is greater for a shaft with tension and less for one with thrust than for a shaft without longitudinal stress. For moderate values of the stress the error is from 3·5 — 4 %, and is one of deficit. H. H. Ho.

1213. *The Determination of Minima-Maxima Forces in Certain Problems of Dynamic Balance.* **P. F. Foster** and **J. F. Baker.** (Phil. Mag. 1. pp. 635–641, March, 1926.)—Certain problems in dynamic balance require the determination of the smallest maximum value of a rotating force-vector and the corresponding angle, resulting from the composition of a vector $\alpha = \mathrm{P}(\cos\theta + \cos 2\theta/n)$ with a vector $\beta = -w$, where β revolves with uniform angular velocity and α oscillates along a fixed direction and is a function of the angle θ made by β with the same direction, both vectors having the same origin, P and n being constants. The resulting force F is given by $\mathrm{F}^2 = \mathrm{P}^2(\cos\theta + \cos 2\theta/n)^2 - 2k\cos\theta(\cos\theta + \cos 2\theta/n) + k^2$, where $w = k\mathrm{P}$ and P is made unity. The particular value required in this instance is not forthcoming by treating

F as a function both of θ and h, obtaining maximum values and then solving for a minimum, or *vice versa*, by the usual methods, but it is found necessary to consider each case *per se* and to obtain the solution, should one exist, by particular methods. In this paper the case is treated for $n = 4$, and a graphical solution is exhibited. H. H. Ho.

1214. *Investigations on Plates which Rotate in an Air Current.* **R. Befort.** (Zeits. f. Physik, 36. 5. pp. 374–398, 1926.)—Circular, square and rectangular plates are mounted in an air current in such a way that they can rotate about an axis of symmetry, which is placed at right angles to the direction of the current. If a small motion of rotation is started in either direction, this continues and attains a velocity which depends on the velocity of the current. The author has investigated the relation between these two velocities; this depends on the form and magnitude of the plates, the number of revolutions per second being proportional to the velocity of the air for circular and long rectangular plates rotating about the axis of symmetry parallel to the long sides; for square plates rotating about an axis of symmetry parallel to one of the edges the speed of rotation tends towards a limiting value as the speed of the air current increases. The number of eddies sent out per second can be calculated from Kármán's formula for the rectangular plates, and can be compared with the speed of rotation; the ratio between them lies between 0·9 and 1·4. In all cases the speed of rotation is independent of the direction of rotation and of the size of plates when the shape is the same. H. N. A.

1215. *Periodic Winds and Critical Squalls for the Bending of Pylon Shrouds.* **C. Platrier.** (Comptes Rendus, 182. pp. 763–765, March 22, 1926.)—It is shown in this mathematical note that for a pylon shroud of given length, section and constant compression there always exist critical sinusoidal winds and sinusoidal hyperbolic squalls of unlimited number. H. H. Ho.

1216. *An Experimental Method for Investigating the Working of Belts.* **R. Swyngedauw.** (Comptes Rendus, 182. pp. 441–443, Feb. 15, 1926.)—Each element of a belt when running is subjected to variations of length which are related to the acting tensions. The purpose of this paper is to describe two stroboscopic methods for the study of the belt velocity at any particular point: (1) Based on the comparison of the speed of a point of the belt with that of the pulley; (2) by direct measurement of the difference of speeds at the extremities of a given arc on the belt. H. H. Ho.

1217. *Centrifugal Force and Newton's Third Law.* **A. Bernini.** (N. Cimento, 2. pp. 439–484, Oct.–Nov.–Dec., 1925.)—Collects and animadverts upon the various methods of expounding and illustrating those in current use, and puts forward a recension. A. D.

1218. *Determination of the Centrifugal Moment $\iint xy\,dx\,dy$ of a Plane with the Aid of the Integrator.* (Zeits. Instrumentenk. 46. pp. 16–19, Jan., 1926.)—Describes and illustrates by numerous curves a graphic procedure due to H. J. Amsler & Co., whereby the centrifugal moment (product of inertia) of a plane may be simply and accurately determined. E. F.

1219. *Determination of the Moment of Inertia of a Surface of Revolution by Means of the Integrator.* (Zeits. Instrumentenk. 46. pp. 19–25, Jan., 1926.)—The determination of the moments of inertia of certain surfaces of revolution involves integrals in which the function to be integrated is dependent on two primary variables and cannot be directly evaluated by means of the integrator. Applying to the present problem the fundamental idea of the method of determining the product of inertia of a plane, the desired moments can be calculated in the case of a surface of revolution. The paper, due to A. J. Amsler & Co., contains numerous curves and is entirely mathematical. E. F.

1220. *Towing Resistance of a Float due to the Formation of a Field of Waves.* **E. G. Barrillon.** (Comptes Rendus, 182. pp. 46–48, Jan. 4, 1926.)—The float on which the dynamometric measurements are made is placed in a field of artificial waves formed by one or several other floats. In order to apportion the resistance between friction and wave formation various arrangements were employed: (1) A float navigating in the wake of another axial float generating the waves; (2) a float navigating in the system of divergents of a generating float, these divergents being reflected from fixed walls so as to form a new divergent system at a point distant from the generating float; (3) a float navigating in the system of divergents of two lateral semi-floats; (4) a float navigating in the field of combined waves resulting from the simultaneous formation of systems 1 and 3. The experiments show that it is possible to annul the direct towing resistance by placing the float in a suitable artificial field of waves, and that the interferences between divergents are as important as between transversals, the latter having hitherto been taken as the sole basis for explaining the variations of resistance at constant speed observed on floats with a variable cylindrical portion. E. F.

1221. *The Intrinsic Equations for the Plane Parallel Motion of Incompressible Continuous Viscous Fluids.* **M. Girault.** (Comptes Rendus, 182. pp. 444–446, Feb. 15, 1926.)—The equations derived in this mathematical paper offer no advantage over the classical equations for solving problems relating to the flow of fluids around obstacles, but they do permit a readier analysis of the variations of the different functions which characterise the fluid. In fluid layers which surround a body, and in which viscous influence plays an influential *rôle*, large variations of speed are shown in general to be accompanied by only small variations of pressure which in certain cases may vanish. Applications to aerodynamics are foreshadowed, *e.g.* cylinders turning in an air current (the Magnus-effect). H. H. Ho.

1222. *Boundary Conditions of Aerodynamical Problems supplied by the Kinetic Theory of Gases.* **Y. Rocard.** (Comptes Rendus, 182. pp. 446–448, Feb. 15, 1926.)—Referring to Girault's work [see preceding Abstract], in which the method given in a previous paper is utilised [see Abstract 2296 (1924)], the author now makes use of Chapman's distribution function, which is the approximation corresponding to the viscous fluids of hydrodynamics. Considering only plane motion and adopting Girault's notations, the equations at the boundary become: $V/R' = -2/3d \log \rho/dt$, $\partial V/\partial s = -1/3\, d \log \rho/dt$, $\partial V/\partial a = -V/R$. The second equation is integrated, and leads to $V\rho^{\frac{1}{2}} =$ constant along the boundary. If, as is generally the case, there is a point of the boundary where the relative velocity of the gas is zero, the deduction is that the constant is zero and the gas at rest relatively to the boundary $V = 0$. The last equation therefore gives $\partial V/\partial a = 0$. Zijnen's measurements (Thesis, Delft, 1924) of the velocity of a liquid current in the immediate vicinity of a glass wall appear to support this conclusion, assuming the accuracy of the velocity determinations made at 0·01 mm. from the wall. E. F.

1223. *Fluid Resistance to Moving Spheres.* **R. G. Lunnon.** (Roy. Soc., Proc. 110. pp. 302–326, Feb. 1, 1926.)—Spheres of steel and other materials have been allowed to fall for varying distances in buildings and in pit-shafts [see Abstract 738 (1924)], and time measurements made for distances up to 538 metres, a Wood phonic dial chronoscope being used. The results have been compared with those expected from a law of resistance, $F = \psi\rho d^2v^2 + b\dot{v}$, $\psi =$ drag coefficient, $\rho =$ air density, $d =$ diameter, $v =$ speed, $b =$ a constant. The terminal velocity is found to be given by $24\sqrt{m/d}$ very nearly, m being the mass of the sphere. For the first few seconds of the fall the resistance is very well represented by $Fg = kmv^2$, k varying with the material, but the ratio of F to v^2 is very different from that at critical velocities ; in the initial stages v is a linear function of v^2. The results can be well represented by the relation $k = 0{\cdot}3d^2/m$, giving $F = 0{\cdot}00031d^2v^2$. From an examination of the figures for greater distances it has been possible to draw curves showing the relation of ψ to the Reynolds number, R, for any acceleration. Dimensional theory would indicate a relation between F/d^2v^2, vd, and $\dot{v}d/v^2$, but such was not obtained. For this to be true, b would also have to be proportional to d^3—it appeared to be much more nearly proportional to d^2. Apparently some other quantity is of importance, possibly the rate of change of the acceleration. A few observations with rough (rusty steel) spheres indicate that roughness diminishes resistance. W. G. B.

1224. *Measurement of Liquid Velocities and the Paradox of du Buat.* **C. Camichel, L. Escande** and **M. Ricaud.** (Comptes Rendus, 182. pp. 29–31, Jan. 4, 1926.)—A note relating to certain improvements in the methods of measuring fluid velocities. Pitot Tube.—The dynamic orifice is connected to the static through a pump and a fine tube. The pump, which consists of two Pitot orifices in the annular space between a fixed and a moving disc, the latter driven by a motor provided with a tachymeter, equalises the pressure. A float or dust particles in the fine tube serve as an indicator. The apparatus gives very accurate results, and will measure quite small velocities, of the order of 5 cm./sec. Propeller Type.—This was calibrated by towing it in a rectangular channel containing liquid at rest and also in a channel in which liquid flowed. The points from both lie on one straight line. These experiments show that the paradox of du Buat disappears if the velocity field is uniform. Photographic Method.—For a model of small dimensions, neither of the above methods is suitable, on account of the disturbance it would produce. The photographic method can be used in the region of turbulence, as the variations of velocity along a stream-line are not nearly so great as is generally supposed. Along a stream-line of length 15 cm. at speeds in the neighbourhood of 15 cm./sec., the variations do not exceed 3 % of the mean. The exactness of the method was also verified by comparing the quantity calculated from photographs with the actual discharge. These were 1·36 and 1·33 l./sec. respectively. **W. G. B.**

1225. *The Harmonic Analysis of Irregular Motion.* **N. Wiener.** (J. Math. Phys., Mass. Inst. of Technology, 5. pp. 99–121, Feb., 1926.)

1226. *Wave-Resistance: Some Cases of Unsymmetrical Forms.* **T. H. Havelock.** (Roy. Soc., Proc. 110. pp. 233–241, Feb. 1, 1926.)—A feature of the curves showing the variation of the wave-resistance with speed is an oscillation about a mean curve, representing interference between the waves produced by the front and rear portions of the model. In experimental curves the magnitude of these oscillations is much less than in the theoretical ones, of which fact fluid friction may be the cause. Without attempting to introduce viscosity into the equations, the effect may to some extent be simulated by imagining the model smoothed out behind. Two cases of models with a blunt bow and a sharp stern are worked out —one submerged, when the terms giving rise to the oscillations are definitely of a lower order of magnitude than in the case of fore and aft symmetry; the other of infinite depth, and again the magnitude of the oscillations is less than in the symmetrical case. It is inferred that any smoothing-out of this type will reduce the oscillations. **W. G. B.**

1227. *The Pressure of Radiation.* **W. F. G. Swann.** (Phil. Mag. 1. pp. 584–593, March, 1926. Paper read before the Am. Phys. Soc., April, 1924.)—The author criticises the classical derivation of the pressure due to the incidence of radiation on an absorbing or reflecting surface, which is founded upon that equation of electrodynamics which is usually regarded as representing the law of the conservation of momentum. [See, for example, H. A. Lorentz's " Theory of Electrons," pp. 28–29.] A modified and more rigid derivation is then given for cases where (1) the plate is allowed to move under the pressure, (2) the plate is held fixed. The general procedure for cases intermediate between complete absorption and complete reflection is shown to be then sufficiently obvious. Finally, the case is taken where the laws are not entirely electromagnetic, a force F of non-electromagnetic origin being introduced into the fundamental equation of electronic motion. The conclusion is reached that the force per unit area due to the field E_0, H_0 of the incident wave *plus* the force per unit area due to F is equal to the energy per c.c. in the incident wave for the case of complete absorption, or twice that amount for complete reflection. **T. B.**

1228. *A New Formulation of the Laws of Quantisation of Periodic and Aperiodic Phenomena.* **M. Born** and **N. Wiener.** (J. Math. Phys., Mass. Inst. of Technology, 5. pp. 84–98, Feb., 1926. Zeits. f. Physik, 36. 3. pp. 174–187, 1926.)—The representation of the quantum laws by matrices [see Abstract 45 (1926)] incurs serious difficulties in the case of aperiodic phenomena, *e.g.* in the extreme case of uniform rectilinear motion, since no periods are present, the coordinate matrix q can have no element outside the diagonal $m = n$. However, even if m and n are continuous, this is not possible in any proper sense. In consequence the authors now attempt to generalise the quantum rules in such a manner as also to embrace these singular cases. The paper is entirely mathematical, and deals in § 1 with the calculus of operators, in § 2 with the mechanics of quanta, in § 3 with the harmonic oscillator, and in § 4 with unaccelerated motion in one dimension. The authors claim their representation to be as close to classical theory as seems consistent with the foundations of the quantum theory. H. H. Ho.

1229. *On Quantum Mechanics. Part II.* **M. Born, W. Heisenberg** and **P. Jordan.** (Zeits. f. Physik, 35. 8–9. pp. 557–615, 1926.)—This mathematical paper is an extension of the hypothesis of Part I [see Abstracts 45 and 447 (1926)] to the quantum mechanics of systems of several degrees of freedom. The disturbance theory is applied to non-degenerate and to a large class of degenerate systems and its connection established with the special Hermite expressions. The results obtained are applied to the deduction of expressions for direct and rotatory impulse and to the derivation of selection rules and intensity formulæ. Finally the theory is applied to the statistics of the fundamental oscillations of a hollow space. H. H. Ho.

1230. *On a Field Representation of the New Quantum Mechanics.* **K. Lanczos.** (Zeits. f. Physik, 35. 11–12. pp. 812–830, 1926.)—The Heisenberg-Born-Jordan new theory of quantum mechanics [see Abstracts 45 and 447 (1926)] is now shown to be intimately connected with the theory of integral equations. The equations of motion and the quantum condition are expressed in the form of integral equations, and a continuum conception is derived which has equal claims to the discontinuum conception, since between the two a simple arrangement exists. This integral formulation has the preferential advantage also of being in agreement with the ordinary field representations of physics. H. H. Ho.

1231. *Crystalline Structure of Chrysoberyl.* **W. L. Bragg** and **G. B. Brown.** (Roy. Soc., Proc. 110. pp. 34–63, Jan. 1, 1926.)—Examination by the ionisation spectrometer and by photographs taken with a revolving crystal show the structure of chrysoberyl to be based on a simple orthorhombic lattice, $a = 4\cdot420$, $b = 9\cdot390$, and $c = 5\cdot470$ Å.; the unit cell contains four molecules of $BeAl_2O_4$. The positions of the beryllium atoms in the structure cannot be deduced from the results, as these atoms play so small a part in X-ray diffraction. The ratios and absolute values of the axes are in accord with an arrangement of the oxygen atoms in hexagonal close-packing, the distance between nearest atomic centres being 2·7 Å., and the relative intensities of the spectra show that this arrangement actually exists. The aluminium atoms lie in spaces between six oxygen atoms. The close-packed arrangement of oxygen atoms can be proved to be slightly distorted by the presence of aluminium atoms in certain of the spaces, but the extent of the distortion cannot be measured. T. H. P.

1232. *Quasi-Limiting States in Crystallised Bodies.* **L. Grenet.** (Comptes Rendus, 182. pp. 318–320, Feb. 1, 1926.)—By adjusting to the critical state the conditions controlling the phase equilibrium, such as pressure and temperature, two amorphous phases originally distinct may be gradually brought to an identical phase. The curves connecting some property of each of the phases with a determinant of the equilibrium tend to become tangents when the critical or quasi-limiting state is approached. Reference is made to a diagram given by Duhem representing the thermodynamic potential of two phases as a function of temperature. This method of examination is applicable to the allotropic forms of alloys of ferro-silicon, ferro-nickel, and ferro-cobalt. The condition for the quasi-limiting state is given by the position where the tangent of the equilibrium curve is parallel to the temperature axis. [See Abstract 173 (1920).]

J. N. P.

1233. *Mutual Orientations of Crystals determined by the Single Coincidence of a Plane Lattice of the Two Substances.* **L. Royer.** (Comptes Rendus, 182. pp. 326–328, Feb. 1, 1926.)—Reference is made to the earlier work of V. Barker on mixed crystals, and especially on the structure obtained when NaCl is deposited on a crystal of NH_4Br, or the reverse. It is shown that only two surfaces exist along which these two substances may form a joint crystal, and the mutual orientations of the two crystals is determined uniquely by the identity of the two plane lattices. This holds also for haloid salts of NaCl or $NaNO_3$ structure, haloid salts and galena, and the haloid salts of CsCl structure. It is stated that the chemical nature of the atoms has little, if any, effect on the phenomenon of mutual orientation, and that the pure geometrical coincidence of the junction plays the principal, if not the sole part, but this coincidence may sometimes be reduced to a question of plane geometry in the junction plane.

R. S. R.

1234. *On the Radiograms of Mixed Crystals.* **G. Friedel.** (Comptes Rendus, 182. pp. 741–744, March 22, 1926.)—The author maintains that the radiograms of mixed crystals should not be interpreted as indicating a constant parameter. The parameters given by the diagrams are merely the statistical average of the most probable distribution of a finite number of parameters lying between those of the pure constituents.

J. E.

1235. *The Effect of Rolling on the Crystal Structure of Aluminium.* **E. A. Owen and G. D. Preston.** (Phys. Soc., Proc. 38. pp. 132–147; Disc., 147, Feb., 1926.)—Sheets of aluminium have been examined by the ionisation spectrometer and by photographic methods with a view to discriminating between two contradictory results obtained by previous observers with the photographic method as to the final orientation of crystals in rolled material. The results show that, when a cast specimen of aluminium containing a number of large crystals oriented at random throughout the body of the material is rolled, the crystals break up into a large number of minute crystals. As the thickness of the material is progressively diminished, the small crystals tend to take up a definite orientation, each crystal having a cube diagonal in the direction of rolling and a (211) plane in the plane of rolling. Two sets of crystals exist in the material after rolling, the one set being the optical image of the other in the plane of rolling. The observations obtained by the ionisation spectrometer indicate that the type of the space lattice remains unaltered, and that the parameter of the material in the severely worked condition does not differ from that of the annealed material by more than 0·5 %.

AUTHORS.

1236. *Structure of α-Quartz.* **R. E. Gibbs.** (Roy. Soc., Proc. 110. pp. 443–455, Feb. 1, 1926.)—The results of investigations on quartz show that the structure can be only partially defined by the symmetry and the

X-ray data. The complete determination involves more parameters than can be evaluated by these means, solution of the remaining four unknown variables necessitating intensity measurements and study of the general physical properties. Observations of the intensities of reflection from a number of planes by oscillation, rotation, Laue photographs, and the ionisation spectrometer prove that the oxygen atoms lie neither in the same basal planes as the silicon atoms nor midway between them, but occupy positions $\frac{c}{9}$ above and below these planes. The variation in the values of the physical properties favours the view that only a small structural change accompanies the transition from β- to α-quartz, although the tetrahedral character of the former structure must be lost. A structure is suggested according to which the crystal is non-molecular and the oxygen atoms occupy basal planes, as mentioned above. Evidence is advanced that the silicon atoms move about 0·3 Å.U from their β-positions. The possible distinction between the causes of pyro- and piezo-electricity are discussed, and calculation on the basis of an assumption made gives for the coefficient of piezo-electricity a value of the same order of magnitude as the accepted value. T. H. P.

1237. *An X-Ray Examination of i-Erythritol.* **W. G. Burgers.** (Phil. Mag. 1. pp. 289–303, Feb., 1926.)

1238. *The "Plattenringe" of Biaxial Crystals.* **C. Schaefer** and **A. Herver.** (Zeit. techn. Physik, 7. 3. pp. 98–105, 1926.)—A theoretical treatment followed by experimental results. The general equations of the cone of equal path differences for a plate cut parallel to an optically symmetrical plane are developed; also the equations and form of the "Plattenringe." Experimental results with topas, mica and gypsum are given with plates. [See also Abstract 2399 (1923).] J. E.

1239. *The Growth of Crystals.* **C. H. Desch.** (Engineering, 121. pp. 488–491, April 16, 1926. Two lectures delivered before the Roy. Inst., March, 1926.)—Suggests that the original shape with which a growing crystal starts is globular, and mentions the experiment of Nacken on salol, in which, when the cooling was very slow, a small rounded crystal was produced. Explains with the help of a diagram why during continued growth the slowly growing faces are likely to survive, and discusses Volmer's experiments on sublimation by condensation of the vapours of zinc, cadmium and mercury on glass in a vacuum, which showed the greatest velocity of growth perpendicular to the jet. The first film formed one molecule in thickness; the adsorption layer was not originally crystalline, but the atoms or molecules could re-arrange themselves to two-dimensional nuclei. Mentions Quincke's foam-cell theory of the solidification of fused metals; a specimen of chromium steel was exhibited which showed the foam-cell structure. The surface of a button of gold formed of a single crystal solidified slowly appeared smoothly rounded, but under the microscope it appeared wrinkled, as if covered by an elastic skin; this indicates the existence of surface-tension, and this may cause rounding of the edges of small gold crystals 300° C. below the melting-point. Explains the formation of dendritic crystals when for any reason the supply of material during crystallisation is not rapid enough to produce well-developed regular crystals; in metals such growth can probably be explained by the flow of heat in the liquid and its relation to the latent heat of fusion. A number of interesting forms are discussed; periodic crystallisation is described and illustrated. One form of this was observed with potassium dichromate jelly, which formed spherulites with a banded structure similar to that of agates. **H. N. A.**

1240. *Modern Theories of Atomic Structure.* **K. K. Darrow.** (Bell System Techn. J. 4. pp. 407–458, July; 642–684, Oct., 1925, and 5. pp. 96–102, Jan., 1926.)—A long description of the experimental facts upon which the theory of the Rutherford-Bohr atom is based. In the first part the inadequacy of an atom model based entirely on classical dynamics is noted and the conception of stationary states traced both from the direct evidence of successive excitation potentials and from the great mass of spectroscopic data. In this connection the working of the different selection principles is explained. In the second part the model for the hydrogen atom and for ionised helium is developed without great detail, and the various striking numerical verifications of the theory are noted. In the last part a general discussion is given of the application of analogous principles to more complex atoms. **A. Wh.**

1241. *Nucleus Impulse and Atomic Structure.* **J. Kudar.** (Phys. Zeits. 27. pp. 59–62, Jan. 15, 1926.)—Mathematical. The circulating electron has an impulse moment and a magnetic moment. Since the latter may be inclined to the magnetic moment of the nucleus, the resultant magnetic moment of the atom may be anomalous in several ways, as indicated, *e.g.* by the Einstein-de Haas effect [Abstract 1123 (1915)]. These considerations affect the magneto-optical model of the "inclination theory" [Pauli, Abstract 1410 (1925)]. Braunbek [Abstract 22 (1923)] has further pointed out that the Einstein-de Haas effect may be due to the rotation of the nucleus. The author regards the K shell, free of impulse and endowed with a one-quantum moment, as the real seat of the magneto-mechanical anomaly, and applies these considerations to the relativity formulæ of the alkali doublets [Landé, Abstract 1106 (1925)]. **H. B.**

1242. *Thirty-second Annual Report of the Committee on Atomic Weights. Determinations published during* 1925. **G. P. Baxter.** (Am. Chem. Soc., J. 48. pp. 541–552, March, 1926.)

1243. *Atomic Dimensions.* **R. G. Lunnon.** (Phys. Soc., Proc. 38. pp. 93–107; Disc., 107–108, Feb., 1926.)—The paper deals with the diameters of the atoms of the elements, and compares the estimates obtained by various methods—*viz.* (1) Atomic volumes; (2) X-ray analysis; (3) Viscosity of gases; (4) Van der Waals' equation and its modifications; (5) Compressibility; (6) Viscosity of liquids; (7) Viscosity of solutions; (8) Diffusion of ions; (9) Mobility of ions in solutions; (10) Latent heat of solution; (11) Speculations as to atomic laws of force; (12) Scattering of X-rays; (13) Bohr's theory in the case of the hydrogen atom; (14) Ionisation potentials; (15) Band-spectra; (16) Chemical constant; (17) Optical rotation; (18) Molecular films; (19) Langevin's theory of diamagnetism; (20) Impacts of a stream of electrons on gas molecules; (21) Density changes in permutite; (22) Melting-points of solids. The results obtained by these methods, of which an extensive bibliography is given, are fairly accordant, and their mean shows that the addition of an inner electron shell gives an increase in diameter of roughly 0·5 Å. AUTHOR.

1244. *Atomic Weight of Lead from Ancient Uraninite.* **T. W. Richards** and **L. P. Hall.** (Am. Chem. Soc., J. 48. pp. 704–708, March, 1926.)—In a uraninite from the Black Hills, South Dakota, containing 2·15 % of thoria, lead-ratio (corrected for the presence of thorium) 0·225, the authors found lead of atomic weight 206·07. Correcting for the thoria, the atomic weight would be 206·02, and they suggest that the atomic weight of pure uranium-lead should be less than 206. There may be isotopes of smaller atomic weight. The lead-ratio in the mineral indicates an age of at least 1500 million years, which would be higher than any so far assumed. H. B.

1245. *Heisenberg's Quantum Mechanics and the Hydrogen Atom.* **P. A. M. Dirac.** (Roy. Soc., Proc. 110. pp. 561–579, March, 1926.)—A purely mathematical paper which starts with a description of the essential characteristics of the assumptions underlying the algebraic methods employed in Heisenberg's development of the quantum theory. The commutative law of multiplication between two functions of the coordinates and momenta of a dynamical system will not in general be valid, and the basic theorems taking the place of those of classical dynamics are examined. In the case of the hydrogen atom the results of this development are applied and the methods of working demonstrated. A. Wh.

1246. *Ionic Radii.* **Rita Brunetti.** (Accad. Lincei, Atti, 2. pp. 410–415, Nov. 15, 1925.)—The formation of a compound can be considered to take place in two stages, the formation of an ion and the incorporation of that ion in a crystal lattice. In a previous paper [see Abstract 914 (1926)] the change in the limits of X-ray absorbtion for elements and polar compounds of the same elements was shown to be explainable in terms of the change in size of the atoms when ionised. In this paper an attempt is made to apply the theory quantitatively to the cases of certain materials for which experimental data are available. Alkali halides and some sulphides are considered, and the conclusion is come to that the ions of the alkali metals are smaller than the atoms, while those of the halogens and metalloids are larger. A. Wh.

1247. *The Electric Moment of the Benzene Molecule.* **R. Sänger.** (Phys. Zeits. 27. pp. 165–174, March 15, 1926.)—The relation between the internal field F, the external field E and the polarisation P is $F = E + \nu P$. The factor ν, generally a temperature function, is often regarded as a constant which, according to Lorentz-Lorenz, has the value $\nu = 4\pi/3$ for regular crystals, and may have the same value for fluids. The dipole theory of Debye, assuming this value for ν, would make the electric moment μ of benzene imaginary, the author shows. Extending the formula in the sense of Gans, and making ν change with the temperature coefficient of the dielectric constant, Graffunder [Abstract 1211 (1923)] showed that benzene should have no electric moment. Interpreting Gans in another way, Smyth [Abstracts 1748 (1923) and 1070 (1924)] found $\mu = 0{\cdot}2 \times 10^{-18}$, a relatively large value for a body like benzene, assumed to be perfectly symmetrical. Discussing the various researches, the author shows that neither the optical constant which enters into the relations, nor the thermal changes in the dielectric constant can be determined with sufficient accuracy to question the symmetry of benzene on these grounds. In a supplementary note he makes similar considerations for ethyl ether and ethyl alcohol, the latter a liquid tending to associate. Conclusions as to the electric moment can only be based upon the thermal properties of vapours. H. B.

1248. *Molecular Weights of Carbohydrates by Radiograms.* **E. Ott.** (Phys. Zeits. 27. pp. 174–177, March 15, 1926. Paper read in part before the Schweiz. Phys. Gesell., Zürich, May, 1925.)—Assuming that the unit cell of the space lattice contains at least one molecule, and that the diameter of an atom in a crystal remains nearly the same in different combinations, Röntgen-ray examination should indicate an upper limit for the molecular weights of high polymers. The volume of $C_6H_{10}O_5$ would be 64 $Å^3$. Examination by means of iron or copper rays gave for diamylose 22 (2) molecules, for tetramylose 12 (4), for octamylose 63 (8), for hexamylose 6 (6); the figures in brackets are those assumed by Karrer and other chemists. For cellulose the author finds 3, for starch 2 molecules, both in agreement with chemical estimates; lichenin gave 7 molecules. H. B.

1249. *Relative Proportion of the Isotopes of Lithium.* **M. Morand.** (Comptes Rendus, 182. pp. 460–462, Feb. 15, 1926.)—The positive-ray beams corresponding to the two lithium isotopes are received on two plates connected to galvanometers and the relative currents measured. New methods for the production of positive rays enable this experiment to be carried out successfully. With small currents of the order of a few microamperes, the atomic ratio of lithium 7 to lithium 6 is 1 : 14 to 15, in good agreement with the chemical value. With a greater emission this ratio appears to fall to 2 or 3. This is traced to the dispersion of the beam of lithium 7 rays until some actually fall on the receiving plate for lithium 6. If a dispersion curve is constructed for the lithium 7 ray, a correction can be made which brings back the ratio to about 15. It is considered that the anomalies observed by Dempster were due to this effect. A. Wh.

1250. *Models of Electron Structure, Quantum Action, and the Gravitational Field.* **W. M. Thornton.** (Phil. Mag. 1. pp. 13–31, Jan., 1926.)—The notes have been written for students of electrical engineering to suggest, by the aid of models, a picture of an electric structure of matter. They make no pretence to be more than a rough mechanical scheme based on the assumption of a vortex ether, of which each element has torsional elasticity. The existence of such a filament implies a basic twist, in this case probably dynamic. The suggestion made by the author is that electrons and protons are produced by applying to it left- or right-handed twists, the effect of which is in the one case to unwind the original torsion, in the other to increase it and form a densely packed thread. In the process loops are formed which are either electrons or protons. Once formed in a medium with the properties of a fluid, they persist. G. W. DE T.

1251. *The Electronic Rotary Impulse of Rotating Molecules.* **H. Lessheim.** (Zeits. f. Physik, 35. 11–12. pp. 831–849, 1926.)—The behaviour of rotating molecules having an electronic impulse moment [see Abstract 1387 (1924)] in an electric field, and more especially the deflection of a molecular ray in a non-homogeneous field, are discussed, the mathematical analysis being carried out to a second approximation. The significance of the electronic rotary impulse in the discussion of the decrease of the specific heat of rotation of the hydrogen molecule is also briefly referred to. J. S. G. T.

1252. *Relativity Theory of the Motion of an Electron in the Field of a Fixed Positive Charge.* **M. Bronstein.** (Zeits. f. Physik, 35. 11–12. pp. 863–882, 1926.)—The restricted theory of relativity relates the total energy E of a mechanical system to its mass m by the equation $E = m \cdot c^2$, where c is the velocity of light. The author applies this equation to show that the rest-mass of an electron in the field of a fixed charge is not constant, but a function of their distance apart. The motion of the electron is then investigated as in Sommerfeld's theory of fine structure, but allowing for the variation of rest-mass with position. The electron describes a rosette-shaped path as in the usual theory, except that now the perihelion steadily recedes instead of advancing. The mass of the electron is found to remain constant throughout the motion. Quantum conditions are applied and the radiation frequencies so deduced compared with those of Sommerfeld's theory. The author points out that his is the one-body problem, and the results obtained are not applicable to the hydrogen atom. W. S. S.

1253. *Simple Derivation of the Planck-Einstein Formula.* **M. Katayama.** (Chem. Soc. Japan, Bull. 1. pp. 3–5, Jan., 1926.)—In considering a monatomic solid containing n atoms, it is assumed that each atom oscillates with a fixed frequency ν, its energy being distributed equally for each of three degrees of freedom of atomic motion, and that the energy exchanges for one degree of freedom take place only in integral multiples of a quantum h_ν. The difference between atoms having different quanta of energy are regarded, from the standpoint of energetics, as similar to the difference between isomeric moelcules, the equilibrium between these atoms being treated in the same way as a chemical equilibrium between isomers. Following the mathematical development of the Planck-Einstein equation for the mean energy of an atom in a monatomic solid, it is remarked that the theory of the action quantum (*i.e.* of the energy quantum proportional to frequency) is equivalent to the assumption that the equilibrium of interatomic exchange of energy in a solid can be treated as a chemical equilibrium, to which the Berthelot-Thomsen principle is applicable. A. B. C. L.

1254. *Elementary Treatise on the Special Theory of Relativity.* **L. Brüninghaus.** (Rev. Gén. d'Él. 19. pp. 443–451, March 20, and pp. 483–492, March 27, 1926.)—A simple method for deducing the transformations, the equations of motion and the Maxwellian equations on the basis of the special theory of relativity is discussed. J. S. G. T.

1255. *The Michelson Experiment carried out by D. C. Miller at Mount Wilson.* **J. Weber.** (Phys. Zeits. 27. pp. 5–8, Jan. 1, 1926.)—It is suggested that Miller's experiment cannot be regarded as a repetition of Michelson's experiment affording a positive result. J. S. G. T.

1256. *Recent Work for and against the Theory of Relativity.* **G. Joos.** (Phys. Zeits. 27. pp. 1–5, Jan. 1, 1926.)—Adams's work on the spectrum of the companion of Sirius, Lenard's aberration effect, Miller's results and the repetition of Trouton and Noble's experiment by Tomaschek at Jungfraujoch are critically discussed. J. S. G. T.

1257. *The Special Principle of Relativity and the Limiting Velocity.* **R. Bass.** (Phys. Zeits. 27. pp. 74–79, Feb. 1, 1926.)—The possibility of the existence of effects which are propagated with a velocity exceeding that of light is briefly discussed, and it is suggested that while such possibility is not, on physical grounds, entirely refuted, it is not in conformity with experience. J. S. G. T.

1258. *Transformations associated with the Lorentz Group.* **C. Baraff.** (Washington Acad. Sci., J. 16. pp. 81–87, Feb. 19, 1926.)—Equivalent forms of Einstein's special relativity theory transformation [see Abstract 2277 (1905)] are first given, one of which has been termed by Minkowski the special Lorentz transformation group. Following this comes a statement of the most general space-time configuration that is unaffected or invariant to a special relativity transformation. The physical interpretation of invariants adopted in the paper is that they are quantities or the relations of quantities which appear alike to a stationary observer and to one moving uniformly relative to him, *i.e.* relations which have the same form both in a stationary and in a moving system. The derivation of the special relativity transformations of velocities is then made from the Lorentz form, and found the same as that obtained by Einstein from the consideration of the invariance of the Maxwell equations towards the special relativity transformation. It is found that the transformation equations for velocities form a group of one-parameter transformations. Finally, accelerations are transformed in like manner. H. H. Ho.

METEOROLOGY AND GEO-PHYSICS.

1259. *The Character of Ionisation produced by Spraying Water.* **P. J. Nolan.** (Phil. Mag. 1. pp. 417–428, Feb., 1926.)—Earlier work on the ionisation produced by spraying water had shown the existence of groups of ions with mobilities extending over the range from the ordinary small ions to the Langevin or large ions. Blackwood and Busse said the range of mobilities was continuous, but the author had found more a banded spectrum for the ions. The author used the Zeleny double-electrode method for a further series of tests, and obtained the corresponding current-voltage curves. The form of the curve varies a little from day to day, although the general shape is unchanged. Three definite peaks were found, and the corresponding mobilities agree with earlier results of the author. The mobilities found agree with the results of Dorno at Davos and Knoche over the Pacific. The existence of other ions with different mobilities is not disproved, but they must be present in smaller amounts. R. S. R.

1260. *Energy in the Earth's Atmosphere.* **D. Brunt.** (Phil. Mag. 1. pp. 523–532, Feb., 1926.)—For the general easterly and westerly circulations a value of 3×10^{27} ergs is found for the existing kinetic energy in the atmosphere, exclusive of any additional amounts due to depressions and anticyclones. By turbulence, using Taylor's form of statement of the rate of vertical transference of momentum, it is found that the rate of dissipation of energy is such that from the ground up to 1 km. the loss is 3×10^{-3} kw. per sq. metre, while from 1 to 10 km. the figure obtained is 2×10^{-3}. If this rate were maintained for rather less than a day and no external energy supplied, the whole atmosphere would come to rest; or if the rate of dissipation remained proportional to the total energy the latter would be reduced to one-tenth its original value in three days. From knowledge of the solar radiation, and making allowance for reflection from clouds and the earth's surface, it is shown that only 2 % of this incoming radiation need be converted to make good losses by turbulence. It is commented that no generally accepted theory has yet been put forward to explain the conversion of solar energy into kinetic energy of the general circulation. R. S. R.

1261. *Waves in the Atmosphere.* **A. Defant.** (Meteorolog. Zeits. 43. pp. 49–54, Feb., 1926.)—The results obtained by L. Weickmann in connection with regular pressure oscillations travelling with waves in the atmosphere are examined critically. The author prepared isallobaric charts for the northern hemisphere from an examination of the daily weather charts for January, 1884. The 24-hour change used eliminates partially the longer period changes. For each chart four low and four high-pressure regions existed around the North Pole not quite equally spaced and with a period of six days. Correlation co-efficients were next determined for pressure changes between a point 90° W. of Greenwich and other points successively 10° farther east around the earth and for latitudes 30°–70° N. These show the four waves with positive and negative correlations. The author considers that these periodic changes are caused by waves set up at the tropopause with a maximum amplitude at this height and decreasing amplitude above and below. The simple case is enlarged to include the effect of gravitational waves. The causes of the propagation of these waves and the influence of temperature distribution and of land and sea on the speed are considered. Pre-existing meteorological conditions may destroy the periodic character of the wave in the lower layers by the production of lower secondary waves, and so interrupt the usual periodicity of the weather. R. S. R.

1262. *On the Relation between Wind or Current and Mean Sea-level in the Indian and Atlantic Oceans and the Adjacent Seas.* **P. H. Gallé.** (K. Akad. Amsterdam, Proc. 28. 10. pp. 905–918, 1925.)—The paper forms a continuation of earlier work [see Abstract 649 (1915)], but with more extensive data. It is shown that the range of mean sea-level in the Indian and Atlantic Oceans and the adjacent seas is for the greater part a result of fluctuations of the wind and current in regions either in the neighbourhood of, or far away from, the place where sea-level is considered. For the Indian Ocean the changes in level at Kidderpore, 65 miles from the mouth of the River Hooghly, are closely connected with the N.E. and S.W. monsoons and the consequent departure from normal of the energy of the wind. Fluctuations in the wind system over the Arabian Sea produce similar changes in mean sea-level at Aden. For the coasts of the Atlantic and adjacent seas monthly departures of mean sea-level are tabulated for a number of places and the corresponding cosine formulæ obtained. Generally a high correlation factor exists between fluctuations in speed of the equatorial current and mean sea-levels with a phase difference which increases for stations of higher latitude and greater longitudinal distance from the eastern American coast. In the North Sea, and especially in the Baltic, local influences play a more important part, although a large correlation factor still exists between the equatorial current and mean sea-level. R. S. R.

1263. *The Figure of the Earth and the New International Ellipsoid of Reference.* **W. D. Lambert.** (Science, 63. pp. 242–248, March 5, 1926.)—The International Geodetic and Geophysical Union at Madrid in Oct., 1924, adopted two parameters to define the ellipsoid of revolution of the earth. The value given by Hayford for the semi-major axis (equatorial radius) was taken unaltered, but the ellipticity (flattening) adopted was slightly larger than Hayford's figure. The author shows that the case for adopting Hayford's flattening value is strong, but not conclusive on account of lunar observations and theory. The semi-major axis value is not so well established, and longitude terms suggested by Helmert and by Heiskanen are discussed. A table of values is given for the fundamental elements of the international ellipsoid, and finally a summary is given of lunar methods employed to determine the flattening of the earth. R. S. R.

1264. *Group Velocity of Seismic Waves.* **B. Gutenberg.** (Phys. Zeits. 27. pp. 111–114, March 1, 1926.)—The author considers the instability of the earth's interior to account for the waves produced. For a series of waves with wave velovity v, group velocity C and wave-length L he uses the expression $C = v - L \cdot \frac{dv}{dL}$. The seismograph measures C. Examples of these waves originating in Chili and recorded at five stations are reproduced. These waves are not always recorded at all stations. The same effects are noted for longitudinal, transversal and reflected waves. Calculations are made for Love waves with two superposed homogeneous layers, and curves are reproduced to show the connection between wave velocity and period for different thicknesses of the Sial and Sima layers. Values of the group velocity are tabulated for different periods for thicknesses of 60 and 30 km. Dot curves are constructed for Love waves for Eurasia, the Atlantic and the Pacific, where different thicknesses for the layers exist, while the curves are finally corrected for differences in the elastic constants of the two layers. R. S. R.

ASTRO-PHYSICS.

1265. *The Red Shift of Solar Lines and Relativity.* **C. E. St. John.** (Nat. Acad. Sci., Proc. 12. pp. 65–68, Feb., 1926.)—The separation of the three major causes producing differences between solar and terrestrial wave-lengths is discussed. These causes are shown to be (1) the slowing up of the atomic clock in the sun to an amount predicted by the theory of generalised relativity, (2) radial velocities of moderate cosmic magnitude and in probable directions, (3) differential scattering which is most effective in the longer paths through the solar atmosphere traversed by light from the limb of the sun. (1) is operative for all lines in all parts of the sun, (2) is active downward at very high and upwards at very low levels, whilst (3) manifests itself in the so-called limb effect. J. S. G. T.

1266. *Determination of the Sun's Velocity with Respect to Stars of Magnitude* 9 *to* 10. **P. van de Kamp.** (Lick Observat., Bull. 12. No. 374. pp. 88–103, 1926.)

1267. *Sunspot Temperature.* **V. Bjerknes.** (Comptes Rendus, 182. pp. 448–449, Feb. 15, 1926.)—Reversing the conditions discussed in a previous paper [see Abstract 969 (1926)], the author now supposes a vortex motion showing a minimum at the surface and increasing downwards. The action is then that of a reversed centrifugal pump. The central masses are sucked downwards and heated by adiabatic pressure. We thus get a vortex with a hot nucleus. The two cases are, however, not absolutely reciprocal. In the vortex with a cold nucleus the masses forming the free surface come from below and are cooled by adiabatic expansion, whereas in the case of a hot nucleus the surface layer consists of masses coming from the farthest parts of the surface without undergoing adiabatic pressure. The hot nucleus is thus primarily a subphotospheric phenomenon. Thus by vortex motion we can explain the existence of cooled or of superheated regions. E. F.

1268. *On the Advance of Perihelion of Mercury.* **J. T. Combridge.** (Phys. Soc., Proc. 38. pp. 161–166; Disc., 166–167, Feb., 1926.)—Attention is called to the infinite possibilities of obtaining the Einstein equation for the orbit of a planet by using Newtonian mechanics with an extended potential function. The merits of the other two " crucial phenomena " as such are discussed from this point of view. It is implied that, observational tests being equally satisfied, Einstein's theory is to be preferred on account of its extensive unity and the spontaneity of its results.

AUTHOR.

1269. *Origin of Satellites.* **N. Boneff.** (Comptes Rendus, 182. pp. 513–516, Feb. 22, 1926.)—The author's hypothesis is that satellites, already members of the solar system, have been captured by their respective primaries during the periods of their formations. He follows Faye's hypothesis for the formation of the planets. At this epoch the central nucleus was still feeble, and he shows that the captured satellites revolved in the *direct* sense with speeds greater in proportion to their distance from the primary, and always greater than its rotation speed. If a and b are constants in Faye's law of attraction $(ar + b/r^2)$, during the period of direct motion a is usually large, b and n (angular motion) are very small, and the satellites are then unstable. In time, a diminishes and b increases, and along with this the angular velocity increases, and the satellite's motion in the moving system diminishes; Jacobi's constant changes its sign. When the motion becomes retrograde (and stable) the motion of the satellites revolve round the primary more slowly in proportion to their distance from it; the exterior satellites may even change the sense of their revolution (as in Phœbe and J. VIII and J. IX); the interior satellites that are very close to their primary may have quicker motion than its rotation (as in Phobos). A. S. D. M.

1270. *Statistical Studies of Stars in Spectral Class Be.* **R. H. Curtiss.** (Roy. Astron. Soc. Canada, J. 20. pp. 19–41, Jan.–Feb., 1926.)—The number of stars classified as Be (B-type with hydrogen-emission lines in their spectra) is now 230, and it is probable that further research will bring the number up to 300. The emission is often variable. Stars which are intrinsically brightest in class B tend most strongly to develop emission lines; and the intensity of the $H\alpha$ and $H\beta$ lines increases on the average with the number of other hydrogen emission lines present.

Be stars show high concentration towards the galactic equator, like normal B stars, but show some departures from the galactic distribution which may perhaps be significant. Their proper motions average slow for their spectral class and apparent magnitudes. Be stars appear to be generally of high luminosity, great mass, and early spectral class (*i.e.* high ionisation). M. A. E.

1271. *Cepheid Variables.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 86. pp. 86–93, Jan., 1926.)—The consequences of two theories of Cepheid variables are critically analysed. One advanced by Shapley and Eddington assumes a spherical radially pulsating star; the other due to the author—a star rotating in that state of secular instability which precedes fission. Objections to the pulsating star theory are: (1) The luminosity should be in phase with r instead of $d/dt \,.\, r$; (2) the light curve should be symmetrical with regard to time; (3) the pulsation would be damped out in a time of the order of 100,000 years, and this duration is too small to account for the observed proportion of Cepheids; (4) all amplitudes would occur, whereas amplitudes below a certain minimum are not known; and (5) oscillations of different and incommensurable frequencies might occur in one star, and there is no evidence of this. On the fission theory all these points are satisfactorily met, except perhaps (2). The fission theory would not make any individual light curve symmetrical, but there appears to be no reason against them being statistically symmetrical. This difficulty has been felt in a different form on the double-star theory, and it seems possible that it may be avoided when a more complete knowledge of the physical conditions is available. A. Wh.

1272. *Kinetic Theory of an Ionised Gas.* **E. Persico.** (Roy. Astron. Soc., M.N. 86. pp. 93–98, Jan., 1926.)—In order to take into account the action of multiple collisions, an expression is used for the law of force between ions which takes into consideration the induced charge round the ion dealt with. Debye and Hückel used a similar method in connection with strong electrolytes, and their expressions are used with a modification due to Eddington. The induced density is assumed to be equal to the average electron density within a distance r_0 of the nucleus, and thence to fall off according to Debye and Hückel's expression. Thus two expressions are given for the potential at a distance r, which are interrelated by the conditions making $d\phi/dr$ and ϕ continuous at r_0. Numerical values are inserted to correspond with the conditions at a point in the interior of the sun where the temperature is about 2/3 of that at the centre. The coefficient of diffusion of the electrons among the ions is found to be 21, which gives for the viscosity a value 4·2. (The viscosity of olive oil is about unity.) A. Wh.

1273. *Effect of Viscosity on a Pulsating Star.* **E. Persico.** (Roy. Astron. Soc., M.N. 86. pp. 98–100, Jan., 1926.)—The average rate of dissipation of energy in a pulsating star is calculated and evaluated, using the viscosity estimated according to the method given elsewhere [see preceding Abstract]. In the typical Cepheid case, δ Cephei, the order of the time of decay of the oscillations is 10^{18} sec., and will not be observed. A. Wh.

LIGHT.

1274. *The Dependence of Light-velocity upon Movement of the Source.* **G. Wataghin.** (Accad. Lincei, Atti, 2. pp. 554–562, Dec. 20, 1925.)—Discusses the various hypotheses possible. Preliminary experiments with luminous canal-rays as sources and a fixed mirror (relative to the observer) give negative results unfavourable to the ballistic hypothesis. A. D.

1275. *Reflection in Systems in Motion.* **G. Fiegna** and **G. Valle.** (N. Cimento, 3. pp. 33–48, Jan.–Feb., 1926.)—The results of Valle [see Abstract 2669 (1925)] extended to the more general case in which the direction of velocity of the system comprising the observer, the source, and the mirror does not lie in the plane of incidence. A. D.

1276. *Transformation of One Trichromatic System into Another.* **W. Dziobek.** (Zeits. Instrumentenk. 46. pp. 81–84, Feb., 1926. From the Reichsanstalt.)—A kind of centre-of-gravity problem, worked upon König's fundamental triangle instead of the colour-pyramid. A. D.

1277. *Dynamics of a Particle and Geometrical Optics.* **L. de Broglie.** (J. de Physique et le Radium, 7. pp. 1–6, Jan., 1926.)—Deals with analogies between particle dynamics and geometrical optics. The problem of propagation of light in refracting media on the corpuscular theory is treated in a new way. W. H. Ge.

1278. *Optical Properties of Chromatic Emulsions.* **C. M. Sogani.** (Phil. Mag. 1. pp. 321–333, Feb., 1926.)—A detailed experimental and theoretical study is made of emulsions of glycerine with turpentine and with mixtures of benzene and acetone, stabilised after the method of Holmes and Cameron [see Abstract 1271 (1922)]. With non-homogeneous emulsions a case is cited in which, with a thickness of emulsion of 3 cm. and a mean diameter of closely packed particles of 0·003 cm., the region of transmission amounts to about 200 Å.U. in the yellow. The region of transmission widens with increase of intensity of the incident beam, and decreases with increase of thickness of emulsion. Emulsions in which the particles of the disperse phase are finer transmit a wider region than those containing coarser particles. Increase of concentration of the disperse phase narrows the transmitted spectrum. A theoretical analysis, based on the principles of the wave-theory and the theory of probability, yields the expression I (intensity of transmitted light) = exp. $-[16/9\pi^2 td(\mu - \mu^1)^2/\lambda^2]$, and it is shown both theoretically and experimentally that the emulsion as a whole has a definite refractivity of its own simply related to that of the two phases. An expression is obtained and verified for the distribution of intensity in the halo. Light scattered by homogeneous emulsions gives a discontinuous halo concentrated in well-defined circular diffraction rings. The expression $\sin\theta_n = n\lambda/d$, obtained for the angular diameter of the first ring, is verified. A. B. C. L.

1279. *Diffuse Reflection.* **G. I. Pokrowski.** (Zeits. f. Physik, 35. 5. pp. 390–393, 1926.)—Henning and Heuse [Abstract 1974 (1922)] deduce an empirical law for reflection at an angle r of light normally incident on a MgO surface. This law is $H_r/[H_{r=0}] = 1 + 1\cdot 3 \sin^2 (r/2)$. The author shows that for any angle i of incidence the theoretical intensity of the reflected light at angle r is

$$I_r = \frac{a}{2}F(i', d) + b \cos r + \left[\frac{a_1}{2}F(i', d) + b_1 \cos r\right]B,$$

where $$F(i', d) = \frac{\sin^2 (i' - d)}{\sin^2 (i' + d)} + \frac{\tan^2 (i' - d)}{\tan^2 (i' + d)},$$

$i' = \frac{1}{2}(i + r)$, $d = \sin^{-1}(\sin i' \cdot /n)$, $B = \cos i \cos r \cdot /(\cos i + \cos r)$, and a, b, a_1, b_1 are constants depending on the nature of the reflecting surface. When the reflecting surface absorbs little light, the terms in $F(i', d)$ are vanishingly small, and the author purports to deduce an approximate law

$$\epsilon = \frac{H_r}{H_r = 0} = \frac{I_r}{I_{r=0} \cdot \cos r} = M + M_1 B,$$

which is confirmed by experiments on MgO surfaces, for which $\epsilon = 0\cdot 675 + 0\cdot 65B$, or, with other samples of MgO, $\epsilon = 0\cdot 73 + 0\cdot 54B$. Hutchins' measurements (Sill. Journn. 6. 373, 1898) lead to $\epsilon = 0\cdot 66 + 0\cdot 68B$. This law gives results closely approximating to those of Henning and Heuse.

A. D.

1280. *Artificial Double Refraction caused by Pressure on a Glass Cylinder.* **H. Rieth.** (Ann. d. Physik, 79. 2. pp. 145–176, Feb. 18, 1926.)—In the first case considered the cylinder is mounted with its axis horizontal and subjected to a radial pressure over its lower half. This is balanced by a vertical downward pressure applied at the upper end of the vertical diameter of the face. The distribution of tension in the cylinder is calculated mathematically and compared with that found experimentally from the double refraction in the glass at various points. The agreement is fairly satisfactory. In less detail the two following cases are considered: (*a*) Pressures applied at the ends of the same diameter; (*b*) pressures applied at points 120° apart.

A. A. D.

1281. *Time Change of the Double Refraction of Flow in Sols with Non-Spherical Particles. I. Vanadium Pentoxide. II. Benzopurpurin.* **H. Freundlich** and **H. Dannenberg.** (Zeits. phys. Chem. 119. pp. 87–103, Jan., 1926.)—Quantitative measurements have been made of the gradual alteration of the flow double refraction or ageing of vanadium pentoxide sols [Abstract 813 (1925)]. The change is greatly retarded by arsenic acid even in small proportions, but is not influenced by phosphoric acid; electrolytes, such as sodium chloride, have little effect. It seems that this change in vanadium pentoxide sols is due, not to coagulation, but to dissolution of the smallest of the pentoxide particles, followed by their deposition on the larger particles. In the case of benzopurpurin sols, however, the course followed by the curves expressing the ageing in presence of various proportions of sodium chloride suggests that the effect is one of coagulation.

T. H. P.

1282. *Some Optical Properties of the Eye.* **C. Sheard.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 79–118, Feb., 1926.)—A long

paper dealing with the application of subjective skiascopy to chromatic aberration of the eye, the chromatic variations in the interval of Sturm and allied phenomena. Details are given concerning (1) suitable luminous fixation objects, screens and diaphragms, (2) backgrounds, and (3) forms of the test-object producing the retinal shadow. The method is used to investigate or determine (1) the amounts of refractive error or correction needed for fixation distances from 22 to 1 ft.; (2) values of peripheral and central refraction; (3) the general effects of diaphragms on vision; (4) changes in amount and character of astigmatism—wave-length curves with change in fixation distance at about 1 ft.; (5) variations in astigmatic error in passing from primary to secondary refractive meridian; (6) possibility of accommodative astigmatism; and (7) depth of focus and lag of accommodation. Thirteen conclusions relative to chromatic aberration and allied phenomena are submitted. The author's summary and conclusion occupy nearly four pages, and the original should be consulted.
W. H. Ge.

1283. *Scattering of Light in the Eye.* **G. I. Pokrowski.** (Zeits. f. Physik, 35. 10. pp. 776–782, 1926.)—Gives an experimental method for measuring scattering in the eye. A theoretical treatment of the results is also given. W. H. Ge.

1284. *The Cœlostat of the Einstein Tower in Potsdam.* **E. v. d. Pahlen.** (Zeits. Instrumentenk. 46. pp. 49–67, Feb., 1926.)—Preliminary description of new apparatus for which various advantages are claimed. The paper consists mainly of figures, tables and mathematical calculations, and cannot be usefully condensed. E. F.

1285. *A New Objective of Great Light-gathering Power.* **L. Bertele.** (Zeits. Wiss. Phot. 24. pp. 31–39, Feb., 1926.)—The Ernemann Werke, Dresden, are shortly producing a new objective of high light-gathering power which will be specially useful for microphotography, micro-projection kinematography and colour shapshots. The objective will be called the Ernostar. The structure and corrections of the objectives are described. J. E.

1286. *A New Ultra-violet Filter.* **C. Winther** and **E. H. Mynster.** (Zeits. Wiss. Phot. 24. pp. 90–96, March, 1926.)—The filter is made up of two solutions each in cells 1 cm. thick: (1) a 2·6 % solution of $CuSO_4 . 5H_2O$ with a sixfold addition of ammonia; (2) a 0·045 % solution of diamond fuchsin in water. The maximum transparency is at 375 $\mu\mu$, and the near ultra-violet (405–320 $\mu\mu$) is transmitted well. It is possible to use ordinary glass for the cells, so making the filter very cheap. In another filter a 0·1215 % solution of K_2CrO_4 was used. [See also Abstract 2152 (1923).] J. E.

1287. *Measurement of Photometric Efficiency.* **A. Blondel.** (Comptes Rendus, 182. pp. 739–741, March 22, 1926.)—Deals with the measurement of photometric efficiency of optical apparatus by the aid of the small portable photometer described in a previous paper. [See Abstract 273 (1926).] W. H. Ge.

1288. *Experiments on the Theory of the Vane Radiometer.* **H. E. Marsh.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 135–148, Feb., 1926.)—An extension of previous work on the subject by the same author. The following points are now investigated: The earlier experiments are repeated with a more homogeneous source of light and better conditions. A new type of vane was used which had, on the two sides of the vertical axis, equal area moments but edge moments in the ratio of two to one for grid and solid side respectively. Lower pressures were used and grease joints in the apparatus were eliminated. Temperature differences between the illuminated and non-illuminated faces of the vanes were actually measured by special thermocouples, and these were expressed as a function of the pressure. A torsion method for quartz fibres was used to measure the actual force exerted on the vanes. It was concluded that the effective portion of the vane is the narrow region along its edge for pressures where the mean free path of the molecules does not approach the dimensions of the vane. In cases where the ratio of edge moments is not too great Einstein's theory that the vane deflection should be proportional to the edge moment of the vane is confirmed. For a large ratio of edge moments the cooling effect of the greater edge length reduces the temperature differences between the two halves of the vane and renders the greater edge moment less effective in producing radiometric action. The Einstein theory predicts that the deflection should be independent of the pressure for constant temperature difference. It was found that the sensitivity increased fourfold with pressure decrease. Probably, however, this can be accounted for on a temperature basis. Finally, it seems as though the action of the ordinary vane radiometer can be roughly accounted for by the simple Einstein theory. S. G. B.

1289. *The Spectroscopic Detection of Minute Quantities of Mercury.* **J. J. Manley.** (Phys. Soc., Proc. 38. pp. 127–128, Feb., 1926.)—Details are given of a method whereby vertical spectrum tubes (demanded by certain investigations) can be critically examined for vanishingly small quantities of mercury. The tubes have two U-limbs partially immersed in insulated water. The water serves as external electrodes. An end-on view of the glow within the excited tube is obtained by a totally reflecting prism formed upon the summit of one of the limbs. The light is thus deflected horizontally and received in the usual way by a spectrometer. AUTHOR.

1290. *Diffraction Phenomena of a Sectorial Grating.* **(Miss) A. Boutaric** and **V. F. Demora.** (J. de Physique et le Radium, 7. pp. 45–51, Feb., 1926.)—Deals with the theory of a grating made up of sectors of equal angle radiating from a common centre and alternately opaque and transparent. The experiments were carried out with two gratings photographically prepared containing respectively 64 and 128 sectors of each kind. W. H. GE.

1291. *Annealing of Optical Glass.* **A. A. Lebedeff.** (Rev. d'Optique, 5. pp. 1–30, Jan., 1926.)—An important factor in annealing optical glass is the discontinuous change in refractive index at a critical temperature associated with polymorphic transformations in the glass. This may leave a residual variation in the refractive index amounting to several units in the third decimal place. The polymorphic transformation takes place in the same way as that in solid solutions. At any temperature in the critical region there is a definite complete equilibrium, and a rela-

tively simple method of measuring the refractive index of the glass in this state is given. The results show that the refractive index is then a linear function of the temperature. A method for transforming glass to the modification stable at lower temperatures is given, and the part played by (i) presence of internal strain and (ii) lack of homogeneity are discussed.
W. H. Ge.

1292. *Fraunhofer Diffraction Phenomena for a General Polygonal Aperture.* **E. E. Witmer.** (Phil. Mag. 1. pp. 132–138, Jan., 1926.)—The most prominent features of the pattern produced by a polygonal aperture consist of lines radiating from the image of the point source, there being two opposite lines at right angles to each side of the polygon. If two sides of the polygon are parallel the corresponding rays show fringes, more or less pronounced according as the sides are or are not equal. Where a side has no second side parallel to it, however, the illumination falls off continuously. These conclusions are based on mathematical approximations which fail for a region near the centre of the pattern. They have been verified experimentally. The phenomena may be observed on star photographs taken through an iris diaphragm. C. W. H.

1293. *Polarisation of Light from the Night Sky.* **J. Dufay.** (Comptes Rendus, 182. pp. 331–333, Feb. 1, 1926.)—A photographic method was employed to examine the light from the night sky at different distances from the zenith and in different directions. Observations of a clear sky at Montpellier and later Courbons (Basses-Alpes) indicated that a feeble polarisation always existed near midnight, the plane of polarisation at midnight being that containing the sun. A formula is obtained which represents satisfactorily the observed variation in the fraction of light which is polarised. The variation of the polarisation with the angular distance from the sun is similar to the changes in daylight with a maximum near to 65°–70°. The author considers that night-sky illumination is due to large particles and not molecules of the gases present in the outer atmosphere. R. S. R.

1294. *Electromagnetic Double Refraction.* **A. Pontremoli.** (Accad. Lincei, Atti, 2. pp. 416–419, Nov. 15, 1925.)—The action of an external field on the propagation of plane polarised light through a gas composed of molecules of which the electric and magnetic properties are defined by ellipsoids of revolution is considered. The resolution of the resultant light into plane polarised components is characteristic, but for a final discrimination between the hypotheses of anisotropic molecules and permanent moments the mechanical reaction of a non-conducting liquid in a rotating field is considered essential. A. Wh.

1295. *Rotatory Power of Camphor.* **R. Lucas.** (Comptes Rendus, 182. pp. 378–379, Feb. 8, 1926.)—In a previous note the author has shown [see Abstract 2264 (1925)] that the variations of rotatory power of camphor in different solvents—cyclo-hexane, benzene and their mixtures—can be explained in the following manner: The camphor can exist in two molecular forms having different rotatory powers and dispersion, the proportion of the two forms being variable according to the solvent employed. The present experiments confirm this hypothesis and yield results of greater precision. A. B. W.

1296. *Rotatory Dispersion of Camphor.* **L. Longchambon.** (Comptes Rendus, 182. pp. 769–771, March 22, 1926.)—In a recent note [see preceding Abstract] R. Lucas has shown that certain anomalies in the rotatory power of camphor in solution depend upon the existence in the solution of right- and left-handed bodies having different dispersions. The present paper agrees with the experimental observation of Lucas, but disagrees as regards the physical interpretation of the results. A. B. W.

1297. *Use of Measurement of Magnetic Rotation in the Analysis of Mixtures.* **M. Jacob.** (Comptes Rendus, 182. pp. 573–574, March 1, 1926.)—The use of magnetic rotation for analysis, in the same way as natural rotation is used, has suffered from the difficulty of obtaining a sufficiently constant magnetic field by the use of a current. This difficulty is solved by a compensating device. The specimen and a compensating tube are placed end to end in the solenoid carrying the current. The compensator contains a half-wave plate which can be moved along it. Its rotatory effect is thus that due to the *difference* of the lengths into which it divides the compensator. Compensation once effected is independent of the current strength. W. G. B.

1298. *Diffusion of Light in Liquids.* **Y. Rocard.** (Comptes Rendus, 182. pp. 690–691, March 15, 1926.)—Systematic experiments have shown four causes which are sufficient to account for the variation in ρ of 0·07 in the values of different observers. Measurements as free as possible from these errors have been made for CCl_4 and C_6H_6. These have been measured in red light, as both are strongly fluorescent. The values are meant for checking molecular theories of diffusion. F. S.

1299. *The Optical Anisotropy of Some Simple Inorganic Gaseous Compounds.* **K. R. Ramanathan** and **N. G. Srinivasan.** (Phil. Mag. 1. pp. 491–496, Feb., 1926.)—One of the present authors has recently shown [see Abstract 1856 (1925)] that the optical anisotropy of some of the common inorganic gases, which is evidenced by the imperfect polarisation of the transversely scattered light in these gases, can be explained if the mutual influence of the polarisation of the different atoms in the molecule is taken into account. In the present paper measurements of the depolarisation of the light scattered by the gases HCl, SH_2 and NH_3 are described, and the results obtained are discussed in their relation to the structure of the molecules. The depolarisation in a direction perpendicular to the incident beam is in all cases the same, *viz.* 0·008, indicating a high degree of optical symmetry. The value of the anisotropy supports the view that in these gases the electrons belonging to the hydrogens have gone over to the outer orbits of the heavier atoms in order to complete the electronic structure characteristic of the nearest inert gas. It is also pointed out that the values of the depolarisation of nitrogen and CO, both obtained visually, have practically the same value, supporting the view that the configurations of the outer electrons of these molecules are similar. A. E. G.

1300. *Mutarotation of Mixtures of Molybdates and of Ethyl Malate. Probable Constitution of Molybdomalic Derivatives.* **E. Darmois.** (Comptes Rendus, 182. pp. 455–457, Feb. 15, 1926.)—Experiments on the mutarotation of mixtures of sodium molybdate and diethyl malate at 80° C.

indicate that the saponification of the malate takes place in two stages, in the first of which a monoethyl malate combines with molybdic acid to give a lævorotatory compound, MoO_3, $2C_4H_4O_5NaEt$, whilst in the second stage the second ethyl group is removed with formation of a dextrorotatory compound having the composition $4MoO_3$, $2C_4H_4O_5Na_2$.
T. M. L.

1301. *Optical Rotatory Dispersion.* **T. M. Lowry.** (Nature, 117. pp. 271–275, Feb. 20, 1926. Lecture delivered before the Soc. Chim. Physique, Paris, Dec., 1925.)—A general review has been made of the extensive research carried out by Biot by which he established the law of inverse squares for optical rotation for quartz plates and various solutions and was led on to the behaviour of optically active solutions. Normal and anomalous rotatory dispersion were thus identified. Recent research on the same subjects by Arndtsen, Lowry, and by Lowry in conjunction with others is summarised, and theories which have been introduced to account for these effects of normal, anomalous and quasi-anomalous dispersion.
R. S. R.

1302. *Researches on the Accidental Birefraction of Colloids in Motion.* **D. Graffi.** (Accad. Lincei, Atti, 3. pp. 28–31, Jan. 3, 1926.)—Experiments on the birefraction of Bravais iron in motion in a tube of rectangular section. With crossed nicols a diversity of the field was observed according to whether the principal section of the polariser was at 45° or parallel to the axis of the tube. In the first case all the samples showed a luminous field. In the second some showed a black central fringe and luminous edges and others an entirely dark field. In the case of these last samples, the optical axes being one parallel and the other at right angles to the axis of the tube, if the birefraction were not accompanied by dichroism, with the polariser at 45° the components along the optical axes of vibration should remain equal on issuing at the centre, whereas marked dichroism was found, as previously observed by Diesselhorst and Freundlich [Abstract 671 (1916)]. The direction of the axes of the elliptical ray issuing at the centre was determined with a Soleil polariscope. In the absence of dichroism, given the position of the polariser, they should form an angle of 45° with the axis of the tube, instead of which they were at 20° and 70° from the said axis. The dichroism followed Majorana's rule: the slower wave was the more absorbed. As a tentative explanation of this birefraction an initial anisotropy of the particles of the colloid and their orientation along the lines of current due to the motion in the tube is premised. This is called birefraction of the first type. That caused by internal deformation, to which Pontremoli's theory is applicable, is called birefraction of the second type. The hypothesis of two types of birefraction may explain the phenomenon of Kundt's black cross shown by some liquids in motion between two circular concentric cylinders whose optical axes are not at 45° with the vector ray as required by Maxwell's hypothesis. It may also explain the inversion of the sign of the accidental refraction of gelatin. The working out is mathematical.
E. F.

1303. *On Some Recent Researches on the Accidental Birefraction of Colloids in Motion.* **A. Pontremoli.** (Accad. Lincei, Atti, 3. pp. 75–77, Jan. 17, 1926.)—Commenting on Graffi's paper [see preceding Abstract], the author notes that to explain his results Graffi considers it necessary to distinguish between two types of birefraction, one due to orientation, the other to internal deformation. The author's theory takes both effects into account, bringing them into harmony with the classical conceptions of fluid motion. It is interesting to observe that Graffi's experimental verification of the orientation of the particles confirms the theoretical calculations. It is, further, remarkable that, having eliminated the effects of dichroism, the direct measurement of the shifting of the phase of the two components of the emerging elliptical vibration enables him to calculate by means of the author's formulæ the value of the constants of Bravais iron. The agreement between the author's determinations from the position of the fringes and Graffi's from the shifting of the phase is, allowing for the diversity of the liquids, very close. These new confirmations justify the expectation that observation of the birefraction of liquids in motion will open up a fruitful field of activity for the direct control of hydrodynamic theory. [See Abstract 835 (1922).] E. F.

1304. *Scattering of Light in Air.* **G. I. Pokrowski.** (Zeits. f. Physik, 35. 6. pp. 464–472, 1926.)—The author previously showed [Abstract 76 (1926)] that light falling on particles slightly greater in dimensions than the wave-length of the light is scattered by reflection and refraction as well as by diffraction. This paper gives a calculation of the scattering by irregular particles through refraction, reflection and total reflection. It is shown that atmospheric scattering can be accounted for perfectly by irregular reflection and refraction due to dust particles. It is not contended that all the scattering is due to this cause, but stresses that it must be expected in part. A. C. M.

1305. *Influence of Heat on the Properties of Photographic Dry Plates.* **H. M. Kellner.** (Zeits. Wiss. Phot. 24. pp. 63–78, March, 1926.)—Masaki having found that heating of a plate during exposure strongly increases the sensibility, the author tests these and previous observations by exposing two strips simultaneously, one heated in a Scheffer tube photometer. The heating is effected for about four minutes by means of an electric heater plate applied to the film or the glass. Many plates (Perutz, Ilford, Hauff, etc.) are tried. The sensitising effect of heat (optimum mostly near 90°), *i.e.* the increase in the optical density of the developed negative, is strongest when the heat is applied during exposure, weaker for all plates when after exposure, and fairly strong also when before the exposure of slow plates. The heat should be applied to the film side, in the case of thin emulsions heated after exposure to the glass side. The spectral sensibility is affected; the grain size of the silver bromide is not changed, but the distribution is altered, the bromide layer increasing in thickness; the number of silver grains increases, and they become more closely packed in the surface layer, especially with weak illumination. The effects are weaker when the gelatin is quite dry. The heating effect seems to mark the final stage of the maturing process. H. B.

1306. *On the Nature of Optical Sensitising and Desensitising.* **G. Kögel** and **A. Steigmann.** (Zeits. Wiss. Phot. 24. pp. 18–31, Feb., 1926.)—Red sensitisers, such as pina cyanol, etc., are not, as has been often assumed, halogen acceptors, but have themselves a high sensitiveness to red. It is not known which of the two in a dyestuff silver salt film is the more sensitive. Experiments on silver-free dyestuffs show that these are highly sensitive to light. These dyestuffs undergo "latent" changes just as do the silver halides in the presence of light. The light product in the case of methylene-blue, trypaflavin and quinine diazide acts as a reducing agent for silver nitrate, while the usual dyestuffs, such as eosin, erythrosin, etc., appear to reduce less or not at all. Experiments show that silver bromide sensitises methylene-blue and similar dyestuffs to blue and ultra-violet. In short wave light the silver salt is the primary agent, being reduced and oxidising neighbouring substances. In long wave light methylene-blue is the primary agent. In both cases a hydrogen atom of the gelatine or other sensitiser is activated. A similar relation appears to exist between sensitiser and sensitisable substances as between ferment and fermentable substances. J. E.

1307. *Fogging Action of Hydrogen Peroxide.* **W. Clark.** (Brit. Phot. Research Assoc. Lab. Comm. No. 51. Phot. J. **66**. pp. 78–84, Feb., 1926.)—Summaries of the published work dealing with the action of hydrogen peroxide have been given by Sheppard and Wightman [see Abstract 1363 (1923)] and the author. After a brief consideration of recent work the subject is here dealt with as follows: The chemiluminescence theory of the action of hydrogen peroxide; hydrogen peroxide sensitivity and reversal. It is concluded that the mechanism of the fogging action of hydrogen peroxide is still very obscure. The most striking feature about its action is its parallelism with the case of exposure to light. It appears that knowledge of the nature of sensitivity must be obtained by other means in order to give an explanation of the action of hydrogen peroxide. The same difficulties apply to a study of the actions of fogging agents as apply to all investigations of photographic theory, and the chief of these is the specific behaviour of different types of material, the differences between which are unknown, which prevents the formation of any generalisations. A. E. G.

1308. *Topographical Relation with Developing.* **Lüppo-Cramer.** (Zeits. Wiss. Phot. **24**. pp. 1–15, Feb., 1926.)—The usual chemical developing is a deep grain developing by which the grain is more or less completely reduced, while the physical developing in its purest form is naturally a pure surface grain developing. Between these two extremes there are numerous varieties. Various methods of developing are here discussed, with special reference to the depth of the action. In an appendix certain so-called developing paradoxes are considered. Dilute amidol solutions are found to act much more rapidly than a concentrated solution. The chlorides of triamidobenzol, triamidotoluol and diamidoresorsin behave in a similar manner to amidol. A useful list of the papers on the subject of this paper is given. A. E. G.

1309. *Camera for Photographing the Interior of a Rifle Barrel.* **I. C. Gardner** and **F. A. Case.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 159–164, Feb., 1926.)—The camera here described is developed for use in connection with the study of the erosion of the barrel of the 0·30-calibre machine-gun or service rifle. The method is shown by diagram and photographs. A periscope is made of such dimensions that it can travel the length of the interior of the barrel. The periscope is of unit magnification and projects an image of a small portion of the interior of the bore on the moving picture film. The barrel of the rifle is slowly drawn lengthwise along the tube of the stationary periscope, and so a picture of a longitudinal strip of the bore is obtained. A. E. G.

1310. *Photographic Photometry with Intermittent Exposure from the Standpoint of a New Law of Blackening.* **H. M. Kellner.** (Zeits. Wiss. Phot. 24. pp. 41–62, March, 1926.)—The author, in attempting to lay down definite laws regarding the blackening of photographic plates, considers first the place of intermittent illumination in the field of a general law of blackening. An equation is established to connect the so-called Schwarzschild index with the effective amount of light, and the physical significance of the equation in the theory of photographic processes is examined in detail. A photographic law of blackening is then obtained and the relation confirmed by experimental evidence. Lastly, the consequences for practical photographic photometry and sensitometry following from this law of blackening are discussed. A full bibliography of the subject is given. R. S. R.

1311. *Conditions for Photographic Spectrophotometry Free from Objections.* **H. M. Kellner.** (Zeits. Wiss. Phot. 24. pp. 79–84, March, 1926.)—Mainly mathematical, containing calculations of the errors involved in the various methods in use. After reference to the many methods, concludes that only that of Lankshear [see Abstract 760 (1917)] fulfils all the conditions laid down for eliminating errors. J. E.

1312. *Photoelectric Stellar Photometer.* **E. Bouty.** (Rev. d'Optique, 5. pp. 31–36, Jan., 1926.)—Describes in detail a photoelectric photometer attached to a large telescope. The cell is carried on the ocular and is connected to a string electrometer, which is also carried on the telescope by means of a Cardan suspension, so that it always remains upright. The details of construction of the electrometer are given, and it is illustrated in a large-scale photograph. J. W. T. W.

•**1313.** *Photometer without Diffusing Screens.* **C. Perucca.** (Zeits. Instrumentenk. 46. pp. 74–76, Feb., 1926.)—Describes an instrument, based on the principle of the Fabry-Buisson photometer, for the measurement of distant sources. The photometric balance is obtained by means of crossed nicols. J. W. T. W.

1314. *Fluorescence of Zinc Vapour.* **J. G. Winans.** (Nat. Acad. Sci., Proc. 11. pp. 738–742, Dec., 1925.)—A water-cooled zinc arc *in vacuo* was caused to excite zinc-vapour *in vacuo* in a furnace. Certain lines and bands were observed in the fluorescent spectrum of the vapour; the energy scheme is given. In one tube containing mercury as an impurity, a zinc-line was excited by " impact fluorescence." A. C. M.

1315. *On the Monochromatic Excitation of Fluorescence.* **A. C. S. van Heel.** (K. Akad. Amsterdam, Proc. 28. 10. pp. 955–957, 1925.)—A preliminary account of a continuation of earlier work of Becquerel and K. Onnes [see Abstract 918 (1910)] on the fluorescence of uranyl salts at low temperatures. Using the same crystal of autunite as used by

Becquerel, it is found that considerable fluorescence is never excited except by light of exactly the same wave-length as one of the absorption lines. J. E.

1316. *On the Study of Triboluminescence (of ZnS).* **W. Perschke.** (Comptes Rendus, 182. pp. 630–632, March 8, 1926.)—Evidence is cited to the effect that the phosphorescence of ZnS is due to traces of rare earths [see Abstract 66 (1910)]. Triboluminescent ZnS has been obtained by heating ZnS to which traces of Mn or Bi salts have been added to redness. Pure ZnS, prepared from $ZnSO_4$, did not show phosphorescence. Triboluminescent samples were obtained by addition of $Mn(NO_3)_2$ solution. After heating to redness in an electric furnace, samples varying in composition from ZnS : Mn = 1 : 0·5 to 1 : 0·000165 were obtained. Orange triboluminescence was obtained in those from 1 : 0·0165 down, attaining a maximum at 1 : 0·00165. No phosphorescence was observed. The temperature of heating, its duration and the speed of cooling had no effect. Precipitation of ZnS from $ZnSO_4$ by H_2S gave phosphorescent samples not showing triboluminescence. J. E.

1317. *Luminescent Grignard Compounds. Further Studies.* **W. V. Evans** and **E. M. Diepenhorst.** (Am. Chem. Soc., J. 48. pp. 715–723, March, 1926.)—A large number, including twenty not previously prepared, of luminescent Grignard compounds are prepared, and examination shows that light emission during the oxidation of these compounds is more general than has been noted. The only Grignard compounds not yielding luminescence are those in which Mg is attached to a radical of low molecular weight. A table is given in order of brightness of substances yielding luminescent Grignard compounds, suitable solvents for which are also tabulated with reference to their effect on light emission. The *para* position ranks first as to light-giving power. Results obtained confirm the statement that luminescence increases with the weight of the radicle when position and chemical nature remain constant. Illustrations of a number of spectrophotographs of Grignard compounds, including three new ones, are given, and a new method is suggested for the preparation of these compounds by the use of sealed tubes. A. B. C. L.

1318. *The Luminous Properties of the Black Body.* **H. E. Ives.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 75–78, Feb., 1926.)—The lastest values for the constants of the black body are used, in conjunction with the Gibson-Tyndall luminous efficiency curve of the spectrum, to compute the luminous efficiency and brightness of the black body over a large range of temperatures. The value 0·00161 watts per lumen is used for the least mechanical equivalent of light. The computed values agree everywhere to within 1 % with the most recent experimental values. AUTHOR.

1319. *The Relation between Fluorescence and Phosphorescence in Solid and Fluid Media.* **S. J. Wawilow** and **W. L. Lewschin.** (Zeits. f. Physik, 35. 11–12. pp. 920–936, 1926.)—Two new phosphoroscopes are described for investigating phosphorescence of very short duration (10^{-6} to 10^{-4} sec.). From observations with these devices it seems probable that fluorescence and phosphorescence in solid and very viscous media correspond to two entirely different processes between which there is no constant transition, although the optical phenomena of spectrum and polarisation may coincide. Uranium glass showed phosphorescence only. The luminosity of uranium glass and uranyl nitrate begins after cessation of the exciting spark and shows a maximum. A method is discussed and tested of estimating the mean duration of the excitation of the phosphorising molecules by diminishing the absorption of the fluorescent and phosphorescent bodies when illuminated with intense light. Several diagrams and illustrations are given. [See Abstracts 1638, 2488 (1925).] E. F.

1320. *Quantum Principles and Line Spectra.* **J. H. van Vleck.** (National Research Council, Bull. 10. Part 4. [316 pp.], March, 1926.)—This bulletin is a survey of the fundamental postulates and recent developments in the quantum theory of line spectra, with references to the literature and to the work of over 250 different authors. Special emphasis is placed on Bohr's correspondence principle as a focal point for much of the discussion. Among the subjects treated are models of the helium atom and hydrogen molecule, the polarisation of resonance radiation, virtual oscillators, quantum theories of dispersion, and corpuscular light quanta. As far as possible the mathematical development is reserved for a chapter on mathematical technique in the quantum theory, in which perturbation theory methods, etc., are given. A particular effort is made to correlate and contrast the rather confusing different systems of quantisation now in use. Duplication of Sommerfeld's " Atombau and Spektrallinien " is avoided as far as practicable.

1321. *Theory of Light Emission according to the Rutherford-Bohr Model.* **J. Palacios.** (Ann. d. Physik, 79. 1. pp. 55–80, Feb., 1926.)—Making the assumptions that the light emission of an atom does not produce damped wave motion and that the transfer of electrons is determined by chance, a theory is developed which represents satisfactorily the measurements of Wien on light emitted by canal-rays. From this theory and experimental measurements it follows that for the production of H_β and H_γ lines the duration of the radiation is the same. Generalising from this result, Planck's constant, h, can be considered as the product of two universal constants, a time quantum and an energy quantum, whose magnitudes can be calculated. Application of the theory to the measurements of Wien leads to the fact that for electrons in the atom one or more bounding paths exist, which are distant from the centre and correspond to the paths of greatest stability. Values are obtained for the scattering of canal-rays in a gas, and the results compared with Wien's theory, while the intensity of the radiation is also considered. It is found that the hypothesis of light quanta is in complete agreement with the observed facts for canal-rays. R. S. R.

1322. *Quantum Theory of Optical Doublets and their Anomalous Zeeman-Effect.* **J. Kudar.** (Zeits. f. Physik, 35. 11–12. pp. 888–893, 1926.)—For quantum states such as those of the hydrogen atom, integral quantum numbers suffice, but when reciprocal action between the electrons is considered half-quantum numbers appear. For such coupled systems the author, following up previous work on the magnetic and relativity theories of optical doublets, suggests the following general principle: In evaluating " proper energy " (Eigenenergie) the ordinary whole number quantum relations give directly the quantum energies, but for energy of coupling (Wechselwirkungsenergie), in order to obtain the true quantum energy, the simply quantised energy must be integrated with respect to each of the quantum numbers involved in the coupling, the limits of integration being consecutive integers. By this means the introduction of half-quantum numbers is avoided. The simple quantum states between which the integrations are made represent "virtual quantum states," and it is to these that the correspondence principle is to be applied. The general principle is employed to deduce the Zeeman-effect for the doublets in the spectra of the alkali metals for both weak and strong fields. **Errata** (*ibid.*, 36. 2. p. 168, 1926). W. S. S.

1323. *Relativity Doublets and Anomalous Zeeman-Effect possibly explained by a Magnetic Electron.* **F. R. Bichowsky** and **H. C. Urey.** (Nat. Acad. Sci., Proc. 12. pp. 80–85, Feb., 1926.)—A discussion of a tentative suggestion that the electron possesses an intrinsic magnetic field and is a charged magnetic doublet of the magnetic moment of one-half a Bohr magneton. The perturbing effect of other electrons in the atom is neglected. We must choose half-quantum numbers for the azimuthal quantum numbers. Sommerfeld's model for the helium atom should be correct; also we would expect the spectrum of helium to consist of a single and triplet series of lines; but W. H. McCurdy and W. A. MacNair, of Johns Hopkins, have separated the orthohelium lines and found no evidence for a triple structure. A. D.

1324. *Tesla-luminescence Spectra. Part VI. Some Amino-derivations.* **W. H. McVicker, J. K. Marsh** and **A. W. Stewart.** (Chem. Soc., J. pp. 17–20, Jan., 1926.)—In previous papers [see Abstract 2090 (1925)] accounts have been given of the Tesla-luminescence spectra of various benzene derivatives. The present paper contains a brief description of the emission spectra of some aromatic amino-derivatives. The apparatus used was the same as before and the pressures were 1 to 2 mm. It appears that the attachment of the amino-group directly to the benzene ring has the effect of shifting the region of emission towards the red end. Replacement of the hydrogen atoms of the amino-group by alkyl radicals has no profound influence on the spectral emission. A. B. W.

1325. *Excitation of Spectrum Lines by Collision of Electrons.* **G. Hertz.** (K. Akad. Amsterdam, Proc. 28. 8–9. pp. 767–774, 1925.)—A description is given of determinations of the excitation potentials of spectrum lines by electronic collision for the vapours of mercury, helium and neon. The method is that used by previous investigators in which electrons drop through a known voltage into a field-free space containing the vapour under examination, but a greater accuracy is aimed at and sources of error and their elimination are discussed. In particular the bad effect of space-charge is obviated by introducing a small amount of another gas with an ionisation potential below the lowest excitation potential of the vapour under investigation. The accurate results (not yet completed) should give the excitation potentials to some tenths of a volt, but those communicated are to the nearest half-volt. To this accuracy the excitation potentials characteristic of the separate lines and groups of lines in the spectra of mercury, helium and neon agree with those calculated on Bohr's theory, using the values of the ionisation

potentials previously obtained by the author. Preliminary work with the vapours of zinc and thallium was confined to spectroscopic observation, but individual excitation potentials were measured and Grotrian's result, that in thallium the $2p_2$ state is the normal condition, was confirmed.
W. S. S.

1326. *Duration of the Radiation from Positive Rays.* **B. M. Bloch.** (Zeits. f. Physik, 35. 11–12. pp. 894–904, 1926.)—Wien's experiments have shown that the light emitted by a stream of positive rays projected into a field-free space decays exponentially with time, the damping factor for hydrogen lines amounting to $1/T = 4 \cdot 35 \,.\, 10^7$ sec.$^{-1}$. Wien suggests that the radiation from each atom decays according to the same law, but it may alternatively be assumed that the time spent radiating is negligible, the main factor in determining the rate of decay being the average life of an excited atom before transition. To decide between the two views the author observes the light emitted by the positive rays of hydrogen as they pass from a region of strong field to a field-free space. In the field the light emitted shows the Stark-effect, and it is assumed that an atom which starts radiating just before passing out of the field will radiate the Stark frequencies even when it has emerged. Measurements of the maximum distance in the field-free region at which the Stark frequencies are still emitted, coupled with a knowledge of the velocity of the positive rays, will therefore enable the duration of the radiation of a single atom to be calculated. The experimental results obtained show a penetration of the Stark frequencies to a distance of 0·084 mm., the velocity of the positive rays, as estimated by observations of the Doppler-effect, amounting to $4 \,.\, 10^7$ cm./sec. This leads to a radiation duration of the order of 10^{-10} sec. The bearing of this result on the hypotheses as to the mode of radiation is briefly discussed.
W. S. S.

1327. *Intensity of the Resonance Radiation of Mercury-Vapour.* **F. Goos** and **H. Meyer.** (Zeits. f. Physik, 35. 11–12. pp. 803–811, 1926.)—The intensity of the resonance radiation of mercury-vapour discovered by Wood [see Abstract 1226 (1916)] has now been measured by a photographic-photometric method. This has been carried out with respect to the depth of penetration of the exciting light pencil for changes of vapour temperature between 0° and 40° C., and also for alterations in its incidence and magnitude. Full experimental details with data and diagrams are included.
H. H. Ho.

1328. *Quenching of Resonance Radiation and Breadth of Absorption Lines.* **R. W. Ditchburn.** (Cambridge Phil. Soc., Proc. 23. pp. 78–84, Feb., 1926.)—From considerations of probability an expression is deduced for the ratio of intensity of resonance radiation when the pressure of the foreign gas is p to the intensity when it is zero, the quantities involved being reciprocals of the mean time between collision of the mean life of the excited atom. Stuart finds that the former quantity for half-value pressure is sometimes greater than the latter, and explains it by assuming the radius of the excited atom to be much greater than the normal. His results are given for several gases. Similar quantities appear in an expression for width of absorption lines, and the values for gases are discussed in this connection also.
F. S.

1329. *Stark-Effect and Band-Spectra.* **W. Steubing.** (Phys. Zeits. 26. pp. 915–918; Disc., 918–919, Dec. 31, 1925. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—Band-spectra show in some cases the Zeeman-effect; the object of this investigation was to find if there were also a true Stark-effect. A previous experiment [Abstract 683 (1923)] showed qualititatively intensity distribution changes, but no quantitative results were given. Bands are so susceptible to changes in temperature, conditions of excitation, impurities and the like, that great precautions must be taken in interpreting past results. A special arrangement, with a cross electric field applied to a very small annular space, was viewed end-on. The negative CO bands, examined with a quartz spectrograph and a new type of registering microphotometer, showed no difference with and without a field of 67,000 volts per cm. The ultra-violet "water-vapour" bands showed no difference in a field of 97,000 volts per cm. The continuous hydrogen spectrum also showed no change, unlike earlier investigations of the continuous iodine spectrum. Of the secondary hydrogen spectrum, of 100 lines examined more than 90 showed no appreciable shift or resolution. It is concluded that in general band-spectra do not show the Stark-effect, and a new attack is being made on the negative nitrogen bands. A. C. M.

1330. *The Hydrogen Spectrum considered in the Light of the New Quantum Mechanics.* **W. Pauli, Jr.** (Zeits. f. Physik, 36. 5. pp. 336–363, 1926.)—Using the principles of the quantum theory as formulated by Heisenberg [Abstract 45, 1926)], and developed by Born and Jordan, Dirac and Born, Jordan and Heisenberg, the author, using the mathematical method of matrices, shows that the Balmer terms of an atom with a single electron are correctly given by the new theory, and that the difficulties arising in the older theory from the fact that certain additional singular motions are "forbidden," particularly in the case of crossed fields, vanish with the new theory. The effect on the hydrogen spectrum of external electrical and magnetic fields of force is also discussed in terms of the new quantum mechanics. For the present the consideration of the relativity corrections and the calculation of the probabilities of passages from one state to another (intensities) remain unconsidered.

H. N. A.

1331. *Measurement of the Fine Structure of Hydrogen Lines.* **P. H. van Cittert.** (Ann. d. Physik, 79. 1. pp. 94–96, Feb., 1926.)—Discusses the possible sources of error in the use of Lummer-Gehrcke plates. To these possible sources of error Gehrcke makes no allusion in [Abstract 1007 (1926)]. A. D.

1332. *New Lines in Secondary Hydrogen Spectrum.* **W. E. Curtis.** (Phil. Mag. 1. pp. 695–700, March, 1926.)—The first of these series was discovered in Kimura and Nakamura's figures, there being an almost constant second difference of wave-number. Two similar series were then found by means of a graphical method. A table is given of these three series together with all available particulars concerning Zeeman and helium effects, behaviour at high and low pressures, with condensed discharge and also as observed by Richardson and Tanaka, Kimura and Nakamura and at — 252° C. by McLennan and Shrum. It is pointed out that these alleged series rest mainly on numerical relationships. F. S.

1333. *The Secondary Spectrum of Hydrogen at Higher Pressures.* **I. Sandeman.** (Roy. Soc., Proc. 110. pp. 326–341, Feb. 1, 1926.)—The arc spectrum of hydrogen at higher pressures is employed to detect further regularities in the secondary spectrum. Four bands are given whose null lines approximately follow a Rydberg law. Of these the most intense band contains a series already given by Richardson and Tanaka. A, P and R series have been selected fitting along with Richardson and Tanaka's 83Q into a P, Q and R combination, which closely conforms with the Combination Principle. This band is one of four bands whose null lines are given by the Rydberg formula:

$$18567\cdot47 - \frac{109678\cdot3}{(n + 0\cdot159883)^2},$$

where n takes the values 6, 7, 8 and 9. Indications of a band corresponding to the integer 10 have also been obtained. The paper is fully illustrated with several tables of results. S. G. B.

1334. *Spectrum of Ionised Oxygen* (*OII*). **A. Fowler.** (Roy. Soc., Proc., 110. pp. 476–501, March 1, 1926.)—The spectrum of oxygen in the region λ6750–λ1950 has been investigated under different conditions, and many previously unrecorded lines have been measured. Photographs were taken with a Littrow spectograph, a number of quartz spectrographs and a 10-ft. concave grating. Particulars are given of about 400 lines which are attributed to the ionised atom (OII). The structure of the spectrum has been further elucidated, 90 lines having been assigned to the doublet system and 68 to the quartet system. A value of about 240,000 is suggested for the 1*s* term, which, if it represents the deepest energy level, corresponds to an ionisation potential of about 30 volts. The expected similarity to the NI spectrum has been traced. F. S.

1335. *Interpretation of the Hydrogen and Helium Spectra.* **J. C. Slater.** (Nat. Acad. Sci., Proc. 11. pp. 732–738, Dec., 1925.)—Pauli has suggested that there is no interaction magnetically between a closed shell of electrons and valence electrons outside it; he connects double levels in one-electron atoms with a duality in the quantum laws. In that case, H and He should resemble the alkalies and the alkaline earths, except for shielding. The author shows in this paper that such a resemblance exists. A. C. M.

1336. *Infra-red Absorption of N-H Bond.* **E. O. Salant.** (Nat. Acad. Sci., Proc. 12. pp. 74–80, Feb., 1926.)—From the infra-red spectrum of nitrogenous compounds Coblentz showed that an absorption-band at $\lambda = 6\cdot1$ to $6\cdot2\ \mu$ and its first harmonic at $\lambda = 2\cdot96\ \mu$ are characteristic of the NH_2 radical. It seemed to the author to be likely that this band is caused by the N-H bond. Measurements on N-H bonds confirmed this inference. A. D.

1337. *Stripped Oxygen, O_{VI}, the PP′ Group in O_V, and New Aluminium Lines in the Extreme Ultra-violet.* **I. S. Bowen** and **R. A. Millikan.** (Phys. Rev. 28. pp. 144–149, Feb., 1926.)—Lines of stripped oxygen O_{VI} and of O_V.—The oxygen atom holds its last electrons so tenaciously that hitherto no lines assignable to stripped oxygen have been obtained. Using aluminium electrodes and high resolution, the "lithium doublet" of stripped oxygen has been definitely located at 1031·98, 1037·69 Å., the component of shorter wave-length being, as usual with this doublet, the more intense. The use of pure Al electrodes has also enabled the pp' group of O_{V} to be obtained in the fourth order, definitely resolved as a sextuplet, the ratio p_1p_2/p_2p_3 coming out 2·27, reasonably close to the value 2 called for by Landé's interval rule. New aluminium lines between 1250 and 500 Å.—Fifteen new faint lines have been discovered and all definitely placed in their proper series, belonging to Al_{III} and Al_{II}. Ionisation potentials of stripped atoms.—Extrapolation from the known values for stripped atoms in the first and second rows of the periodic table gives values for the 2*s* term which correspond to the following ionisation potentials: for N_{V} 97·39; for O_{VI} 137·35; for F_{VII} 184·07; and for Cl_{VII} 113·73 volts. These are probably accurate to within 0·2 volt. [See also Abstract 1902 (1925).] AUTHORS.

1338. *Second Spark Spectrum of Neon.* **L. and E. Bloch** and **G. Déjardin.** (Comptes Rendus, 182. pp. 451–452, Feb. 15, 1926.)—Experiments carried out with silica tubes containing neon at various pressures have led to the discovery of an entirely new second spectrum of neon, which appears to be the second order spark spectrum of Ne_{III}. This spectrum, like the corresponding spectra of the other rare gases, is entirely situated in the ultra-violet, the strongest and most characteristic lines being found between λ3000 and λ2600 Å.U. A table of the wave-lengths and intensities of the lines of the new spectrum is given. A. W.

1339. *Excitation of Second Spectrum of Neon.* **G. Déjardin.** (Comptes Rendus, 182. pp. 452–454, Feb. 15, 1926.)—A second spectrum of neon has recently been observed in an electrodeless discharge similar to the blue spectra of argon, krypton and xenon. The author has excited this spectrum by electronic impact in a tube with three electrodes, several lines appearing at 48 to 50 volts with pressure of 0·01 to 0·1 mm. of mercury, while the complete spectrum is obtained at 60 volts. A number of lines were observed widened and reversed. Allowing for certain corrections, the two excitation potentials of this spectrum are deduced as 49 and 28 volts respectively. F. S.

1340. *Extreme Ultra-violet Spectrum of Neon.* **T. Lyman** and **F. A. Saunders.** (Nat. Acad. Sci., Proc. 12. pp. 92–96, Feb., 1926.)—Lines at λλ743·73 and 735·95, present as impurities in the helium spectrum, are traced to neon. Other lines are also found, and the series relationships discussed. A. D.

1341. *Production of Some Spectra of Carbon, Oxygen and Nitrogen in the Presence of Neon.* **W. H. B. Cameron.** (Phil. Mag. 1. pp. 405–417, Feb., 1926.)—This work links that previously done on argon [see Abstract 2968 (1924)] to that of Merton and Pilley [Abstract 1371 (1925)] on helium. The discharge-tubes used were of H-pattern with a bore of 15 mm. and furnished with carbon electrodes, quartz window, palladium regulator and side bulbs containing caustic potash and phosphorus pentoxide. The comet-tail bands of carbon were observed, but not so brightly as in helium. The carbon line λ2478 and a number of CII doublets were also observed. In addition to the negative carbon bands, CH bands and Martin's CS bands, a new band system associated with carbon was observed and measured. No trace of the green aurora line was observed in oxygen, but the band-spectra and OI line spectrum were faintly obtained in wide-bore tubes. A number of nitrogen lines were observed, but not so intensely as in helium. In general the action of neon is intermediate to that of helium and argon, and Merton and Pilley's explanation of the action of the former is endorsed, but somewhat modified. F. S.

1342. *Structure of* 4511 *and* 4123 *Bands of Carbon Monoxide.* **(Miss) O. Jasse.** (Comptes Rendus, 182. pp. 692–694, March 15, 1926.)—Hulthén has shown that the bands at 5610, 5198, 4835 and 4393 are similar to other bands in the spectrum, which are degraded towards the violet. The author shows that the bands at 4511 and 4123 have the same sequences but are complicated by others. It is concluded that the 4511 has the same initial state as those on the same level, that 4213 has the same initial state as 4393, and, on the other hand, 4511 and 4123 have the same final state, which is the same as that of 4835 and 4393. F. S.

1343. *Absorption-Spectra of SO_2 and Some Derivatives.* **F. H. Getman.** (J. Phys. Chem. 30. pp. 266–276, Feb., 1926.)—Absorption-spectra taken in solution in water with a Hilger quartz spectrograph and a Judd-Lewis spectrophotometer. SO_2 shows a characteristic band at λ2760; this is attributed to $SO_2 \cdot H_2O$. The absence of CO_2 and oxygen is essential. Beer's law does not apply to any of the substances considered. Freshly prepared potassium metabisulphite gives a band at λ2630, which on standing gives place to the SO_2 band at λ2760. The former band is taken as evidence of the existence of the undecomposed salt in solution. Sodium sulphite shows no selective absorption. Freshly prepared sodium bisulphite gives end absorption only, but on standing in the light in presence of oxygen photo-oxidation of the ion HSO_3^- occurs simultaneously with the appearance of the band λ2760. After thirty days a constant maximum is attained. Cane-sugar retards this, while light is found to be essential. Baly's infra-red relationship applies to both the bands described. A. C. M.

1344. *Displaced Series in the Spectrum of Chromium.* **C. C. Kiess** and **O. Laporte.** (Science, 63. pp. 234–236, Feb. 26, 1926.)—The few cases in which spectra of elements in the first and second long periods have been analysed is explained by the theory developed by Russell and Saunders and further by Hund, which accounts for low terms from the various possible ways of adding the azimuthal quantum numbers of the several valence electrons. The ideas are applied to chromium and a resonance triplet for CrII predicted at about 2035 Å. A strong triplet has been photographed at 2055·51, 2061·50 and 2065·43 by D. D. Laun using a quartz spectrograph of high dispersion. The normal states of neutral and ionised atoms of the first two long periods are also predicted. F. S.

1345. *Closely-spaced Line Spectrum in the Visible Region.* **Marion Eppley.** (Frank. Inst., J. 201. pp. 333–335, March, 1926.)—A method is described of impregnating carbon rods with a mixture of oxides of molybdenum, titanium and vanadium. A photograph is reproduced of the spark-spectrum in the visible region of two such rods. An alloy of Cd, Zn, Pb and Sn is advocated for production of a comparison spectrum for identifying wave-lengths. F. S.

1346. *Spectra of Exploded Wires.* **R. Déchêne.** (J. de Physique et le Radium, 7. pp. 59–64, Feb., 1926.)—The discharge from a battery of Moscicki condensers, charged to various voltages by a transformer, was used to explode the wires and the resulting spectrum photographed by a quartz spectrograph. A continuous spectrum is produced upon which a considerable number of lines are reversed, notably the flame lines. With intense discharge the spark lines are also reversed. Detailed results are given for copper, iron and nickel. F. S.

1347. *Spectrum of Cadmium.* **F. Esclangon.** (J. de Physique et le Radium, 7. pp. 52–58, Feb., 1926.)—The method of L. and E. Bloch has been applied to separate the different orders of the cadmium spectrum, and the results of observed wave-lengths occupy twelve columns. [See Abstract 851 (1924).] W. H. Gr.

1348. *Absorption-Spectra of Aluminium and Cobalt.* **N. K. Sur** and **K. Majumdar.** (Phil. Mag. 1. pp. 451–462, Feb., 1926.)—An account of the results of work done in the high-temperature furnace. This consisted of a graphite tube, heated by a current (680 amps.) from a set of five heavy-discharge accumulators. The $2p_1 - 2s$, $2p_2 - 2s$ lines of Al do not come in absorption until 1520° C. is reached. The higher numbers of the *ps* and *pd* series are obtained in absorption at about 1700° C. It is concluded that the $2p -$ is the normal state for Al under these conditions, but it is emphasised that this can only be said definitely to be the normal state for Al if it can be shown that the number of absorption centres is approximately the same as the number of atoms present. The absorption spectrum of cobalt was photographed from 4500 Å.U. to 3000 Å.U. at 2000° C. The lines are tabulated, and they are compared with Catalán and Bechert's series classification. Many lines belonging to f^1 and f^2, and a few belonging to F^1 terms have been obtained in absorption. Only one line belonging to the group which Catalán and Bechert have suggested for resonance lines has come out in absorption. A. C. M.

1349. *Absorption-Spectrum of Iron.* **N. K. Sur.** (Phil. Mag. 1. pp. 433–450, Feb., 1926.)—The high-frequency spark produced between two iron electrodes immersed in distilled water is analysed by a spectroscope. The exact experimental conditions are described in detail, and the results obtained are compared with the recent work of Laporte on the classification of iron lines. It is shown that all multiplets having the three highest groups of terms—*viz.* d^1, $\overline{f}^1$ and occasionally $\overline{F}^1$ as initial orbits—are obtained in absorption. Some weak lines are also in absorption which are shown to correspond to the transition of the azimuthal quantum number from k to $k + 2$ (violation of Sommerfeld's selection-principle). It is shown that this method of obtaining absorption-spectra is as suitable as the more elaborate method of obtaining it in the furnace. Arguments are advanced in support of the view that iron may have a term higher than the *d*-term, which is the highest so far obtained. A. C. M.

1350. *On the Difference of the Fluorescence and Absorption-Spectra of the Uranyl Salts.* **G. H. Dieke** and **A. C. S. van Heel.** (K. Akad. Amsterdam, Proc. 28. 10. pp. 953–954, 1925.)—An attempt to explain the change of the constant frequency difference in passing from the fluorescent to the absorption-spectra of uranyl salts. J. E.

1351. *Band-Spectrum of Tin Monochloride.* **W. Jevons.** (Roy. Soc., Proc. 110. pp. 365–390, Feb. 1, 1926.)—The spectrum of the uncondensed discharge through $SnCl_4$ vapour comprises, in addition to Sn and Cl lines, a continuous spectrum in the region between λ4900 and λ3950, and a hitherto unrecorded band-spectrum in the near ultra-violet. The bands belong to two distinct sets occupying the regions λ3910–λ3486 and λ3405–λ2830 respectively. The band heads have been measured in the first order of a grating spectrograph. None of the bands have been resolved into lines. Each set is attributed to a chloride of tin. The bands in the more refrangible set constitute two systems, α and β, of the normal Deslandres type. The systems closely resemble one another, (*a*) in their ranges of values of the initial and final vibrational quantum numbers, n', n'' (n' in each system ranging from 0 to 4 or 5, and n'' from 0 to 8 or 9); (*b*) in the intensities of like-numbered bands and in their intensity distribution, which is of a fairly normal type; (*c*) in their progressions of first differences of wave-numbers, and therefore in their vibrational energy coefficients; and (*d*) in consisting of bands which degrade towards the further ultra-violet, indicating that the moment of inertia of the molecule which emits α and β is greater in the final state than in the initial state in the case of each system. The separation $(\nu_\beta - \nu_\alpha)$ of like-numbered bands in α and β increases appreciably with n'', while it is independent of n'. Thus the inter-system separation is largely accounted for by an electronic term (*viz.* the separation of the "origins" of systems α and β), but contains also a vibrational term dependent only on n''. This indicates a common initial electronic state (with its associated vibrational states) and two distinct final electronic states (each with its associated vibrational states) for the two systems. The two (α and β) final electronic states of the molecule are not very different as regards vibrational energies and, therefore, inter-atomic forces. If systems α and β be ascribed to $SnCl^{35}$, a few additional bands in the same region are attributable to $SnCl^{37}$, in accordance with Mulliken's theoretical formulæ for the vibrational isotope effect. This Cl isotope effect affords considerable support for the above assignment of n', n'' in each system. There is also some indication of the Sn isotope effect, which is smaller and more complicated, and accounts for the observed diffuseness of most of the band heads in both systems. The less refrangible set consists of several groups, each containing a few close bands degraded towards the red. The first differences between the wave numbers of the band heads in each group are of the same order from group to group. These bands may be emitted by SnCl, as are systems α and β, or by a polyatomic chloride. A. C. M.

1352. *The Absorption-Spectrum of Tin Vapour in the Ultra-violet.* **R. V. Zumstein.** (Phys. Rev. 28. pp. 150–156, Feb., 1926.)—(1) Arc spectrum.—The spectrum of a 25-amp. arc was measured between 2170 and 1950 Å. and 12 new lines observed. (2) Absorption spectrum of tin vapour, 6000 to 2000 Å.—The tin was heated in a small carbon tube to about 1600° C. and 53 absorption lines were observed, of which 38 are new. (3) Frequency differences.—The results in general support the table of frequency differences given by McLennan, Young and McLay [Abstract 867 (1925)], lines from the normal state X_6 and X_5 showing strong absorption, those from X_4 medium absorption, those from X_2 only faint absorption and those from X_1 no absorption. A new table containing some changes and additions is given, using a different notation, which includes nearly all the arc lines. While the numerical relationships of the energy diagram are now well known, the nature of the terms involved has not yet been determined. AUTHOR.

1353. *Absorption of Salts of Some Rare Earths.* **T. Inoue.** (Chem. Soc. Japan, Bull. 1. pp. 9–13, Jan., 1926.)—The absorption spectra of solutions in water of the chlorides of lanthanum, cerium, proseodymium, neodymium, samarium, and erbium were studied in the ultra-violet (method not described). Bands were confirmed: $\lambda\lambda 3350$ and 2469 in cerius chloride, $\lambda 2600$ in samarium chloride, and $\lambda 2470$ in erbium chloride. Certain bands were found to be unaffected when the salts were mixed, in disagreement with previous observations. A method is based on this for the quantitative estimation of cerium and samarium. A. C. M.

1354. *The Vacuum Spark-Spectra of Some of the Heavier Elements and Series Classification in the Spectra of Ionised Atoms Homologous with Copper, Silver and Gold.* **J. A. Carroll.** (Roy. Soc., Phil. Trans. 225. pp. 357–420, Jan. 9, 1926.)—The paper forms an extension of the work of Millikan and Bowen on vacuum spark-spectra into the field of elements lying in the middle part of the periodic table. Twelve series of spectra have been measured and the results tabulated. These were made for atoms homologous to Cu, to Ag, and to Au, and extending to the third stage of ionisation. Five of these series had been established by other workers from independent considerations, while seven series are based on considerations set out by Fowler, Paschen, Millikan and Bowen, Landé and Hartree for the spectra of atoms like Li and Na. These seven are the doublet spectra HgII, GaIII, InIII, TlIII, GeIV, SnIV and PbIV. The numerical relations between the spectra have been investigated, and the results are tabulated and illustrated in curves. The theoretical results of Sommerfeld, Landé and Hartree are confirmed, and a new rule of the variation of diffused doublet separations with ionisation is proposed. A complete table of the wave-lengths measured is given and full details of the experimental methods employed to obtain the various spectra. Reproductions are included of the spectra obtained using Millikan's vacuum spectrograph for $\lambda < 2300$ Å., while for higher values Anderson's condenser discharge *in vacuo* was used. R. S. R.

1355. *Arc Spectrum of Palladium.* **K. Bechert** and **M. A. Catalán.** (Zeits. f. Physik, 35. 6. pp. 449–463, 1926.)—This spectrum is arranged into singlet and triplet terms, with the ground-term as a singlet S term with $j = 0$. An attempt is made to assign azimuthal quantum numbers to the terms. The ground-term of the palladium spark-spectrum is probably a ^2D term. Comparison with the Fe family shows that chemically analogous elements cannot be relied upon to have the same ground orbits. Magneton curves are given for the Pd and Fe families. A. C. M.

1356. *Absorption-Spectra of Naphthalene Vapour and of Some Methyl Derivatives.* **H. G. de László.** (Zeits. phys. Chem. 118. pp. 369–414, Dec. 30, 1925.)—Work done on naphthalene in hexane solution and as a vapour is described. [See also Abstract 2774 (1924).] The same method as there described for naphthalene is applied to some methyl derivations. There are three types of naphthalene absorption: (1) showing fine structure (triply quantised), λλ3200–2820; (2) narrow bands without fine structure (doubly quantised), λλ2820–2500; (3) wide band without fine structure (singly quantised), maximum about λ2209. The atomic vibrations of naphthalene are characterised by three frequencies: $\alpha = 474 \cdot 4$ cm.$^{-1}$, $\beta = 203 \cdot 4$ cm.$^{-1}$, and $\gamma = 62 \cdot 7$ cm.$^{-1}$. α and β also occur in the infra-red absorption-spectra. α is about one-half the corresponding number for benzene (921·7 cm.$^{-1}$). It is suggested therefore that in naphthalene it corresponds to the mutual vibration of the two benzene nuclei. The fine structure of some of the naphthalene bands can be arranged in parabolic series; the moment of inertia calculated from this is much too small. It is suggested that this is a submultiple of the actual value. The moment of inertia from the infra-red spectrum is put at $96 \cdot 10 \times 10^{-40}$ gms. cm.^{2}. β-methylnaphthalene gives a spectrum more similar to naphthalene than does the α derivative. The methyl group appears to blur the spectrum, ; in dimethylnaphthalene the discrete bands of naphthalene have all run in together. 2,6 dimethylnapthalene has strong bands, and is comparable with p-xylol. A. C. M.

1357. *Comparative Investigations on the Energy and Air-Ionising Action of X-Rays of Different Wave-lengths.* **H. Kulenkampff.** (Ann. d. Physik, 79. 2. pp. 97–142, Feb. 18, 1926.)—By simultaneous measurements of the energy of X-rays of various wave-lengths and their ionising effects, it should be possible to determine the energy required to make a pair of ions and to find whether this value depends on the wave-length. The energy was measured with a sensitive thermopile in combination with an ironclad galvanometer. The total radiation of various antikathodes was used with filters to enhance especially the Kα lines. The spectral distribution was determined with an ionisation spectrometer. It is found in the region studied – 0·56 to 2 Å.U., that the energy required to produce a pair of ions is independent of the wave-length and is equal to 35 ± 5 volts. J. E.

1358. *X-Ray Fluorescence.* **P. Auger.** (Comptes Rendus, 182. pp. 773–775, March 22, 1926.)—Atoms affected by high-frequency radiation exhibit the photoelectric effect; they pass thus to an excited condition, characterised by an ionisation more or less deep. The ions formed are then, after a certain time, the seat of electronic rearrangements which liberate the characteristic X-rays. The author has shown [Abstract 1124 (1925)] that the quanta thus appearing can be produced by electromagnetic radiation, which constitutes the fluorescence, possibly by a kind of internal photoelectric effect. The production of fluorescence, defined as the ratio of the number of characteristic quanta emitted by the atoms excited to the number of incident quanta absorbed, is in consequence diminished by the fact of the existence of the second mode of transformation; the value of this ratio is a measure of the relative importance of the simple and compound photoelectric effects. The phenomena have been studied by the Wilson condensation method and the experimental results discussed in the light of this theory. A. B. W.

1359. *X-Ray Spectra of the Lower Elements.* **R. Thoræus.** (Phil. Mag. 1. pp. 312–321, Feb., 1926.)—This is a continuation of work by Siegbahn and the author [see Abstract 131 (1925)] on an extension of the K- and L-series of the light elements. A special high-vacuum spectrograph is necessary, as absorption is such an important difficulty, and two tubes are described for use with this instrument. As wave-lengths longer than 18 Å. cannot be measured by the earlier known crystals, gypsum, mica, and sugar, the spacings of lauric and palmitic acids have been accurately measured and found to be $2d = 54\cdot536$ Å. and $70\cdot98$ Å. respectively. The wave-lengths of the Ll, $L\eta$, $L\alpha_1\alpha_2$ and $L\beta_1$ lines of most of the elements from Cr to Rb have been measured and tabulated and also the $K\alpha_1\alpha_2$ for F has been found to be $18\cdot30$ Å. Some wave-length difference relations are discussed. F. S.

1360. *X-Ray Absorption-Spectrum of Antimony.* **A. Jönsson.** (Zeits. f. Physik, 35. 5. pp. 387–389, 1926.)—The L_3 absorption constant for pure antimony and a number of its compounds (Sb_2O_3, SbI_3, Sb_2S_3, $SbOCl$, $KSbOC_2O_4$, Sb_2S_5, etc.) is measured with the aid of a Siegbahn spectrograph, layers of the substances being rubbed into tissue-paper so that the specimens were of thickness given by one or two mg./cm.^{2}. The results are given in a single table without a very full discussion.

W. H. Ge.

1361. *On the Intensity of X-Ray Spectra in Relation to the Excitation Voltage.* **H. Stumpen.** (Zeits. f. Physik, 36. 1. pp. 1–17, 1926.)—Intensity measurements were carried out by the ionisation method. A Seeman camera was used and a photograph first taken to give the position of the lines to be measured. As sources were used a Lilienfeld tube with Mo and with W, and a Coolidge tube with Cu antikathode. Up to some four and a half times the critical voltage the results agree with former observers in that the intensity increases with the square of the voltage. Beyond this region the rise is slower. The results of Kettmann [Abstract 549 (1924)] are referred to in connection with the theoretical treatment of B. Davis [see Abstract 1097 (1918)]. It is thought possible that with very high voltages the intensity would reach a maximum. With the L-series a greater increase begins when the voltage reaches the K critical value.

J. E.

1362. *K-Series Emission Spectra for the Elements from Ta(73) to Bi(83).* **B. R. Stephenson** and **J. M. Cork.** (Phys. Rev. 27. pp. 138–143, Feb., 1926.)—The specially designed water-cooled tube enabled currents of 8 milliamp. at 150 kv. to be used. By connecting the same rheostat in the primaries of both high-tension and filament transformers, irregularity due to hot spots on the target was automatically smoothed out. An automatic electromagnetic cutout prevented excessive current when gas developed. With these arrangements, accurate measurements were made of the K-lines for all elements from Ta(73) to Bi(83) excepting Hg, the elements being placed in sheets or layers on the thin copper target. The $\sqrt{\nu/R}$ values plotted as a function of atomic number give practically straight smooth curves, as is to be expected. The differences in the ν/R values for the α and α' lines agree well with the corresponding values for $L\beta$ and $L\alpha'$. The corresponding wave-length differences are nearly constant and equal to $4\cdot85$. Authors.

1363. *Distribution of Energy in Continuous X-Ray Spectrum.* **M. H. Belz.** (Phil. Mag. 1. pp. 50–67, Jan., 1926.)—From the corrected experimental curves given by Dauvillier for a standard Coolidge tube under different constant potentials and currents, an empirical expression of the form $y = a(e^{-bx} - e^{-cx})$ has been found to represent the energy distribution curve with considerable accuracy. By subdividing the form of a sinusoidal potential wave into a number of intervals during which an appropriate constant potential is supposed to act, the application of the empirical expression produces an integral distribution curve, which agrees very well with an experimental curve given by Dauvillier for approximately equal conditions. It is suggested that the energy distribution curve can, in the same way, be predicted when the forms of the potential and current waves are known. A. B. W.

1364. *J-Phenomenon. Part III.* **C. G. Barkla** and **Gladys I. Mackenzie.** (Phil. Mag. 1. pp. 542–553, Feb., 1926.)—Three J discontinuities, J_1, J_2 and J_3, have been obtained in the absorption of one complex beam of X-rays by placing a gradually increasing thickness of aluminium in the path of the beam. By the superposition of two scattered radiations it is shown that the activity of the compound radiation is not the sum of the activities of the two constituent radiations. Each beam, as far as the J-phenomenon is concerned, acts as a whole, and the compound beam, consisting of the two, behaves as a radiation of intermediate absorbability, showing only one discontinuity appropriate to the beam as a whole. The activity of a radiation thus depends, in part at least, as something analogous to temperature of the radiation as a whole. This suggests a separation of the activity of X-rays from the frequency of the radiation and illustrates the coherence of constituent radiations. Two beams of X-rays scattered in directions making angles 60° and 120° with the primary radiation differ, when at all, in one of two ways: (*a*) by the beam at 120° showing the J discontinuities and the other not, or (*b*) by a continuous difference of absorbability in some substances. W. H. Gr.

1365. *The Excitation of Soft X-Rays.* **O. W. Richardson** and **F. C. Chalklin.** (Roy. Soc., Proc. 110. pp. 247–282, Feb. 1, 1926.)—An investigation of several elements by the photoelectric method. The substance under investigation is bombarded with electrons in a highly evacuated space, and the radiation passes between two parallel plates of a vacuum condenser to filter out ions and electrons and is received on a metal plate from which the photoelectric emission could be measured. The photoelectric current divided by the thermionic current is plotted against the potential difference, the excitation of characteristic X-rays setting in at certain voltages could be detected by the existence of changes of slope in the curves so obtained. A description of the apparatus is given and the conditions of satisfactory working discussed. Some of the chief results are: Carbon.—Points of inflexion are observed at 40, 80 and 280 volts, the inflexions at 40 and 80 volts being downward. This does not, of course, prove that the point is not an X-ray excitation potential. An interesting discussion is given of the corrections to be applied to the observed voltage in order to correct for various errors, such as the fall in potential along the filament, the initial emission velocity of the electrons, contact difference of potential between kathode and target. The final values of carbon are 39·5, 81·2, 265·0, 292·8 volts. Tungsten.—Breaks are observed at 36·84, 40·3, 44·9, 70·8, 108·2, 127·7, 150·0, 191, 245·2, 263·7, 336, 395·0, 419·0 volts. Nickel.—Discontinuties at 38·6, 80·0, 88·9, 99·0, 140·3, 245·5, 282·0, 288·0, 316·4, 335·0, 392·4, 433·0, 522·0 volts. Iron.—With improved apparatus the following results were obtained: 45·6, 50·6, 63·7, 75·6, 84·8, 95·0, 107·6, 115·1, 137·6, 189·7, 221·5, 240·6, 270·2, 288·3, 498 volts. The resemblance between nickel and iron is discussed. Finally a comparison of total radiations emitted is attempted, and it is found that the intensity is proportional to the square root of the atomic number rather than to the atomic number itself. It is noted that the atomic absorption coefficient for soft X-rays vary as N^2 rather than N^4. Some of the observed inflexions are identified as belonging to known X-ray series; others may be due to discontinuities in the general X-radiation. W. V. M.

1366. *The Relative Intensities of Reflection of X-Rays from the Principal Atomic Planes of Fluorite.* **D. A. MacInnes** and **T. Shedlovsky.** (Phys. Rev. 27. pp. 130–137, Feb., 1926.)—For these measurements the usual Bragg apparatus was modified by adding a reference crystal illuminated through the same slit on a line slightly above the other, and a second ionisation chamber and Bumstead electroscope. The integrated ionisation as the crystal was turned by motor through a given line or range of wavelength was measured. Correction was made for the general radiation. Thus the relative intensities of the Pd α and β lines when reflected from three principal planes of fluorite were determined. The values fall into three groups for each line, each of which fall on a smooth curve when plotted as a function of the angle of reflection, the strongest group being due to Ca and F atoms acting together, a weaker group to Ca atoms alone, and the weakest group to Ca and F planes which are out of phase with each other. Simple quantitative relations between the intensities of these groups have not yet been found, evidently because an additional absorption by the crystal takes place, which varies in an unknown manner with the angle of reflection. AUTHORS.

1367. *Experimental Investigation of the Refraction and Dispersion of X-Rays by Crystal Reflection in Mica.* **A. Larsson.** (Zeits. f. Physik, 35. 6. pp. 401–410, 1926.)—An account of very careful measurements (using the Siegbahn precision vacuum spectrograph) of the glancing angle for the following spectral lines: $CuK\alpha_1$, $VaK\alpha_1$, $SnL\beta_1$, $KK\beta_1$, $MoL\beta_1$, $SiK\alpha$, and $AlK\alpha$. According to the Bragg law $\sin\phi/n$ is a constant, whereas it is found experimentally that $\log\sin\phi/n = C + A/n^2$, where C and A are constants. If $\mu = 1 - \delta$, and the theoretical expression for δ is correct, δ/λ^2 should be constant. δ may be calculated from reflections in different orders, its value being as below:

Line.	δ.	Line.	δ.
$CuK\alpha_1$	$9{\cdot}35 \times 10^{-6}$	$MoL\beta_1$	106·5
$VaK\alpha_1$	26·4	$SiK\alpha$	$186{\cdot}2 \times 10^{-6}$
$SnL\beta_1$	49·2	$AlK\alpha$	249
$KK\beta_1$	51·4		

The value of δ/λ^2 is found to be approximately constant as required, but a slight maximum is observed in the neighbourhood of the absorption limit of potassium, and may be a true anomalous dispersion. Thus the deviations from the Bragg law are to be interpreted as refraction phenomena in the crystal. W. V. M.

1368. *On the Distribution of Two Kinds of Atoms (Molecules) in Mixed Crystals.* **G. Tammann.** (Ann. d. Physik, 79. 1. pp. 81–84, Feb., 1926.) —A discussion concerning the nature of mixed crystals. The remarks of Laue [Abstract 552 (1926)] about mixed crystals are cited, and the results with a number of binary metallic mixtures are quoted and discussed. It is concluded that the "normal" distribution is exceptional. The contradictory results for 0·25 Au and 0·75 Cu are explained as being due to a time interval being required for the "normal" distribution to establish itself in all the microcrystals. J. E.

1369. *X-Ray Spectrograph.* **H. Seemann.** (Phys. Zeits. 27. pp. 10–22, Jan. 1, 1926. Paper read before the Deut. Physikertag., Danzig, Sept., 1925.)—Deals with an X-ray spectrograph in which the zero-point is determinable without the aid of a divided circle. W. H. Gr.

RADIO-ACTIVITY.

1370. *The Quantitative Measurement of Radium Emanation using a Guard-ring Plate Condensor.* **L. Siegl.** (Inst. f. Radiumforschung, Mitt. No. 174. Akad. Wiss. Wien, Ber. 134. 2a. No. 1–2. pp. 11–37, 1925.)—A description of the measurement of radium emanation by observation of saturation currents between the plates of a guard-ring condensor, together with the necessary calibration of the electrometer. A fairly complete theoretical account of the problems involved in the calculation of the current is included [see Abstract 75 (1913)], as well as a full account of experimental procedure, for which the original should be consulted. W. V. M.

1371. *Estimation of the Radium Emanation in the Atmosphere.* **F. Béhounek.** (J. de Physique et le Radium, 6. pp. 397–400, Dec., 1925.) —Radium emanation is very soluble in carbon disulphide at low temperatures, and this property is utilised in a portable apparatus which measures the amount of emanation present in the atmosphere with an error not greater than 3 %. A sample of air occupying 152 litres is pumped several times through wash-bottles containing CS_2 at a temperature of − 80° C., the process being automatic and occupying about an hour. The quantity of emanation dissolved is tested by allowing air to bubble through the solution into an evacuated ionisation chamber having a capacity of 3 litres, the proportion of emanation extracted in this way being ascertained by comparison with that obtained from a known solution, which serves also for calibrating the Wulf bifilar electrometer which is employed in connection with the ionisation chamber. C. W. H.

1372. *Radium Emanation Measurement of Small Quantities. Application to the Estimates of Radium in Meteorites.* **G. Halledauer.** (Inst. f. Radiumforschung, Mitt. No. 175. Akad. Wiss. Wien, Ber. 134. 2a. No. 1–2. pp. 39–44, 1925.)—A method is described for the measurement of very small quantities of Ra emanation. The method is subsequently applied to the determination of the quantity of radium in a number of meteorites. The quantity observed was of the order 10^{-15} gramme Ra per gramme of meteorite. A. B. W.

1373. *Chemical Properties of Mesothorium 2 and Actinium.* **Ellen Gleditsch and C. Chamié.** (Comptes Rendus, 182. pp. 380–381, Feb. 8, 1926.)—The authors describe a chemical study of the rare earths containing actinium, with particular reference to the methods of separation of the actinium. The method employed consists *not* in dealing directly with the actinium, which presents difficulties of identification, but with its isotope, mesothorium 2, an element very easy to distinguish by its radiation and period of decay. A preliminary investigation served to prove that mesothorium 2 was present in all the rare earths, and in all the chemical separations this was used as an "indicator" of actinium. A. B. W.

1374. *Chemical Action of Alpha Particles on Acetylene.* **W. Mund** and **W. Koch.** (J. Phys. Chem. 30. pp. 289–293, March, 1926.)—The production of a pale yellow powder from acetylene mixed with radon was investigated by measuring the rate of polymerisation. The influence of oxygen, pressure and temperature on the velocity of the reaction were determined. The results showed that no variation exceeding the experimental error could be detected in the number of molecules of acetylene polymerised per pair of ions produced in the system, (1) at different pressures; (2) at temperatures of 0° C., 20° C., 100° C.; and (3) in the presence of small quantities of air. Taking the general mean of eleven measurements (without oxygen) obtained in this study, and of two concordant measurements made previously, the ratio of the number of molecules polymerised per pair of ions produced (– MCH/N . total) is 20·2. F. J. B.

1375. *Disintegration of Atoms by α-Particle Bombardment.* **H. Pettersson.** (Akad. Wiss. Wien, Ber. 134. 2a. No. 1–2. pp. 45–50, 1925.)—By means of the very simple arrangement described it is possible to determine the number of H-particles emitted and the number of α-particles scattered through large angles by suitable screens interposed in the path of α-particles emitted by RaC and ThC. The chief advantage of the method lies in the fact that comparatively weak radio-active sources of α-particles may be employed. The paper contains the results of a series of observations on H-particles from aluminium. A. B. W.

1376. *Regularity in the Actions of Electromagnetic Waves. Nuclear Destruction.* **E. Brummer.** (Zeits. Elektrochem. 32. pp. 7–13, Jan., 1926.)—With decreasing wave-length the effects of electromagnetic waves, limited in the infra-red to ions, whose own frequencies correspond to ponderable particles, are shown by the electrons, first the outer, then the inner, there being no essential difference between the nucleus and the other parts of matter. Electromagnetic waves must thus have a destructive effect which may be concerned in the transmutation of the elements. The author considers from this standpoint the phenomena of light absorption, chemical and photochemical effects, photoelectricity, fluorescence, X-rays, etc. As the frequency increases the more strongly-bound electrons are attacked. The active wave-length can in some cases be calculated. The nitrogen atom is built up of 1C and 2H, the sum of the masses of which is greater than that of the nitrogen atom; in the gramme atom the difference amounts to 0·0094 gr. From relativity considerations the length of waves that should be destructive to nitrogen would be $1\cdot41 \times 10^{-11}$ cm., whilst the energy estimate of the bombarding α-particle in Rutherford's experiments gave $1\cdot62 \times 10^{-11}$ cm. In the case of helium the destructive wave-length should be 10^{-12} cm. Owing to the uncertainty about isotopes similar calculations cannot be made for the other disrupted elements.

H. B.

1377. *Photographic Method of Determining the Mobility of Recoil Atoms.* **G. H. Briggs.** (Cambridge Phil. Soc., Proc. 23. pp. 73–77, Feb., 1926.)—In the experiments described use is made of the photographic action of the radio-active recoil atoms to determine their distribution. The object of the experiments was to determine, if possible, the difference in the mobilities of ThX, ThA and ThB. The following values are given for the max. peak and min. mobilities determined from the displaced band of the photographic record, *viz.* max. 1·84, peak 1·59, min. 1·25 cm./sec./volt/cm. An attempt was made to see if the distribution of the three substances ThX, A and B in the band of activity was the same for each substance by exposing a freshly activated disc to photographic plates for a short time immediately after the experiment, then again after some hours, and finally after several days. No difference in the photographic impression was observed, but this evidence of equal mobilities is regarded as inconclusive. A. B. W.

1378. *Origin of Penetrating Radiations.* **V. F. Hess.** (Phys. Zeits. 27. pp. 159–164, March 15, 1926.)—A critical review of recent work on the penetrating or "ultra-gamma" radiation. Particular reference is made to the work of G. Hoffmann [Abstract 765 (1926)], R. A. Millikan [see Abstract 935 (1926)], and F. Běhounek. A. B. W.

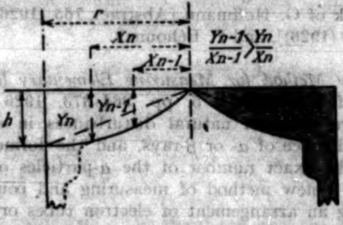
1379. *A New Method for Measuring Elementary Rays.* **H. Greinacher.** (Zeits. f. Physik, 36. 5. pp. 364–373, 1926.)—In the Geiger counter there are so-called natural disturbances in addition to those caused by the entrance of α- or β-rays, and the former cause difficulty in determining the exact number of the α-particles or electrons. The author describes a new method of measuring and counting elementary rays which, using an arrangement of electron tubes or valves, amplifies the effect produced by the primary ionisation due to each α-particle, so that it is possible to observe the entrance of the particle into an ionisation chamber, which is connected with the grid of the first valve, by means of a galvanometer or a telephone. No point is employed in the ionisation chamber, and no discharge is produced as is the case in the Rutherford-Geiger method. Natural disturbances are reduced to a minimum, and can be certainly distinguished from those produced by the α-particles. These are much greater than those due to β-particles, so that it is easy to distinguish between them. Full details of the method, with diagrams of connections, will be found in the original paper. H. N. A.

1380. *δ-Rays produced by α-Particles in Different Gases.* **J. Chadwick** and **K. G. Emeléus.** (Phil. Mag. 1. pp. 1–12, Jan., 1926.)—The tracks of α-particles in four gases—*viz.* hydrogen, helium, air and argon—have been obtained in a Wilson expansion chamber, and the production of δ-rays along them have been studied. As far as the observations go the results are in agreement with the view that the δ-ray arises from the collision of the α-particle with an electron in the atoms through which it passes. It is assumed that, for the distances involved in these collisions, the α-particle and the electron behave as point charges, and that the law of force between them is that of the inverse square. Photographs are reproduced to illustrate the various points discussed in the paper. A. B. W.

HEAT.

1381. *Variation of Thermal Conductivity of Gases with Pressure.* **H. Gregory** and **C. T. Archer.** (Phil. Mag. 1. pp. 593–606, March, 1926.)—Continuing the work of a previous paper [see Abstract 1059 (1926)], the influence of pressure upon the thermal conductivity of air is studied. It is found that, assuming convective losses to be absent, Maxwell's theoretical prediction of the non-variation of thermal conductivity with pressure is true to the order of accuracy claimed in the experimental work. It is proposed to extend the experiments to pressures higher than one atmosphere. W. H. Ge.

1382. *Pistons of Aluminium, "Alpax" and Magnesium.* **R. de Fleury.** (Comptes Rendus, 182. pp. 628–630, March 8, 1926.)—The disadvantages of thin-walled pistons in regard to carbonisation, overheating with consequent ill-effects on scavenging and efficiency, and on the necessary tolerances in diameter, of ribbed pistons in respect of the high heat transfer to the lubricant, and of thick pistons on account of their weight are claimed to be overcome by the design illustrated in the sketch, which is intended to be made in light metal. The advantages accruing from the use of aluminium and magnesium alloys are illustrated by data on their thermal constants. The best results are secured when the expression $\left(\frac{\text{Thermal conductivity}}{\text{Coefficient of expansion} \times \text{Density}}\right)$ is a maximum.



T. B.

1383. *Thermoelectric Effects and the Heat Capacity of Electrons in Metals.* **E. D. Eastman.** (Am. Chem. Soc., J. 48. pp. 552–562, March, 1926.)—In this paper the nature and proper field of application of the apparent heat capacity of electrons in metals, their partial molal heat capacity, and the Thomson-effect are discussed. The apparent heat capacity, c, of electrons is defined as $c = C_V - C_N$, where C_N is the heat capacity (at constant volume) of a mole of metal, and C_V that which would be experienced if the electrons were rigidly fixed in their positions, at the same time leaving all the conditions affecting the motions of the nuclei themselves exactly as in the actual system. The partial molal heat capacity of the electrons in the system is defined as $\bar{C} = (\partial C_v/\partial n)_T$, where C_v denotes the heat capacity at constant volume of a system consisting of n_1 moles of metal ion and n moles of electrons. The Thomson-effect, σ, denotes the heat absorbed by a system consisting of a metal in which a temperature gradient exists when electrons in the metal are transferred reversibly from a temperature T to T + dT, the effect being expressed per mole of electrons transferred and per degree difference in temperature. The conditions under which c, $\overline{C}$, and σ might be equal are discussed, and the available evidence is examined to determine whether such equality exists in actual cases. It is concluded that this is not so for a large majority of the metals studied. The final sections comprise a discussion, in the light of experimental facts, of those theories that would identify the apparent heat capacity or the Thomson-effect with the excess above 3R of the atomic heats of metals at high temperatures. T. B.

1384. *The Coefficient of Dilatation in Amorphous Substances.* **M. Samsoen.** (Comptes Rendus, 182. pp. 517–519, Feb. 22, 1926.)—The results of Abstract 319 (1926) extended to all amorphous substances. All amorphous substances present a discontinuity when the viscosity is 10^{14} poises. A. D.

1385. *Dilatation of Iron and Steel.* **F. Stäblein.** (Stahl u. Eisen, Jan. 25, 1926. Engineering, 121. p. 395, March 26, 1926.)—A description of a relatively simple apparatus for use in steel works for the determination of the expansion of steel up to 1000° C. Curves are given showing the records obtained with the apparatus for electrolytic iron where it is seen that two specimens do not give identical values in accordance with previously known information that different specimens of such iron do not behave alike at the A_3 point, and that the expansion on heating and cooling are different. The latter is ascribed to a distortion of the lattice and difference in the α to γ and γ to α changes. Curves are also shown bringing out clearly the differences in dilatation between steels containing more or less carbon than eutectoid alloy. It is seen that the dilatation curve, which is simple in pure iron, increases in complexity with increased carbon content. The irregularity is less marked as the carbon percentage increases from 0·05 to 0·12, and again from 0·22 and 0·86. In the hyper-eutectoid steels with 0·97, 1·09 and 1·33 % of carbon the slope of the curve is very steep. An attempt is also made to draw the iron-carbon diagram in accordance with dilatation curves. S. G. B.

1386. *A Differential Dilatometer with Mechanical Registration.* **P. Chevenard.** (Rev. de Mét. 23. pp. 92–99, Feb., 1926.)—The author has previously described a differential dilatometer for solids, which records photographically the variation with temperature of the difference between the expansion of the bar under test and that of an alloy standard [see Abstract 536 (1918)]. Mechanical registration has now been obtained by the replacement of the moving mirror by a system of levers which carry a pen arm. Examples given show the results obtained for expansion and contraction of a number of refractories throughout the range of temperature 0°–1000°. A. W. L.

1387. *Specific Heat of Electrolytes.* **F. Zwicky.** (Nat. Acad. Sci., Proc. 12. pp. 86–92, Feb., 1926.)—The author calculates this out by thermodynamical reasoning, taking account of the following factors: (1) The degrees of freedom of the molecules of the solute; (2) change of the specific heat of water due to electric polarisation in the field of the ions; (3) H_2O molecules acting as rigid electric dipoles (P. Debye), and therefore in the inhomogeneous field of an ion attracted towards the ion, cause a high pressure around the ion, which materially affects the specific heat of the water; (4) hydration of the ions; (5) destruction of the ion atmospheres (a space charge of opposite sign round each ion, Milner and Debye) on rise of temperature, and energy required to effect this. A. D.

1388. *Specific Heats of Hydrocyanic Acid.* **Edith H. Ingold.** (Chem. Soc., J. pp. 26–29, Jan., 1926.)—A reply to a critique, presented in a paper by Partington and Carroll [see Abstract 1687 (1925)], on experimental details, and to a suggestion that the results obtained by the author should be attributed rather to the thermal effect accompanying polymerisation than to that accompanying isomeric change. A. B. C. L.

1389. *The Thomson-Joule Effect and the Physical Constants of Air at Low Temperatures.* **H. Hausen.** (Zeits. Vereines deutsch. Ing. 70. pp. 266–268, Feb. 20, 1926. Extract.)—This paper contains a detailed description of the experimental measurement of the differential Thomson-Joule effect of air at temperatures between + 10° and − 175° C., and at pressures up to 200 atmos. From the experimental data, graphical methods are derived for evaluating the thermal content i, specific heat C_p, entropy s, and specific volume v. The dependence of the calculated values for i, s and v on pressure and temperature is shown by $i - T$, $T - s$, and $pv - p$ diagrams. The diagrams involve a pressure range from 0 to 200 atmos., and one of temperature from − 200° to ordinary room values, so that the liquid and saturated regions are included. The apparatus details are very complete. H. H. Ho.

1390. *Determination of the Melting-point of Graphite.* **E. Ryschkewitsch** and **F. Merck.** (Zeits. Elektrochem. 32. pp. 42–45, Jan., 1926.)—Further experiments to clear up one or two doubtful points in the previous investigation [see Abstracts 1432 and 1433 (1925)]. The absorption coefficient of solid, and especially of liquid, graphite at the temperatures involved is not known with sufficient certainty, and the accuracy of the pyrometer readings left much to be desired, the latter reason alone accounting for an error of ± 100°. The apparatus was similar to that previously used, but adapted to pressures ranging from 2 to 9 atmos. The structure of the graphite rod was also modified, as in the method adopted by Pirani and Alterthum [Abstract 1416 (1923)]. In a rod 6·5 mm. thick a central bore of 2·7 mm. in diameter was made, with the main object of diminishing the strength of the current necessary for fusion. The central part of the cylinder was for a length of about 3 cm. narrowed down to 4·5 mm. outer diameter, leaving a wall of about 1 mm. At the centre of the rod a hole 0·4 mm. in diameter was carried as far as the inner bore. The radiation from this hole may be considered as black radiation, the opening being small relatively to the hollow space, and the cylinder walls at equal temperature in the vicinity of the hole. The tabulated figures show a mean of 3845° abs., the greatest divergence from the mean being 45°, and the average divergence about 20°. The melting-point of graphite may thus be considered as lying between 3800° and 3900° abs. Considering the difficulty of measuring these high temperatures, the agreement between the values found by various investigators under differing conditions is remarkably close. E. F.

1391. *Melting-points of Barium, Strontium and Calcium Oxides.* **E. E. Schumacher.** (Am. Chem. Soc., J. 48. pp. 396–405, Feb., 1926.)—A special melting-point receptacle was used. A glass bulb 30 cm. in diameter was effectively sealed, and two heavy copper leads passed through the neck of the bulb. Two molybdenum rods were attached to these leads, and their upper ends slotted. The bent ends of a strip of tungsten 0·635 cm. wide, 0·025 mm. thick and 3·8 cm. long were welded into the molybdenum slots by means of an arc in an atmosphere of hydrogen. The tungsten strip was electrically heated in hydrogen to 1775° abs. for several minutes to free it from traces of oxide. The oxide under test was introduced into the boat, and the whole resealed and evacuated. During evacuation the glass walls were heated to remove absorbed gases. Hydrogen was now admitted through a polladium valve until atmospheric pressure was reached. A further heating to free the boat from tungsten oxide and a subsequent reduction of pressure to 0·2 atmos. were accomplished. The temperature of the boat was then raised electrically until the oxide melted. The melting-point was observed by means of an optical pyrometer. For calcium oxide the melting-point is given as 2849° abs., which agrees with Kanolt's value of 2843°. For barium oxide the melting-point was 2196°, and for strontium oxide 2703°. Notes on other possible experimental methods are given. S. G. B.

1392. *Influence of the External Temperature on the Temperature of a Standard Pyrometric Lamp.* **G. Ribaud.** (Comptes Rendus, 182. pp. 625–627, March 8, 1926.)—Experiment has shown [see Abstract 1506 (1924)] that a tungsten filament lamp, well constructed and carefully "aged," preserves a constant temperature at a given point of the filament within about 1° C., when its temperature does not exceed 1800° C. The author has studied the influence of the external temperature on the temperature of the filament. If the filament is sufficiently long, so that cooling by the supports is inappreciable, then for a central element at temperature T traversed by current i, $\rho i^2 = A(T^4 - \theta^4)$, where θ is the external temperature. For very high temperatures $d\rho/\rho = dT/T$, and for constant intensity, if θ varies, $dT = 4\theta^3 \cdot d\theta/3T^3$, or if cooling by the supports is considered, $dT = 4\theta^3 \cdot d\theta/3T^3 + cd\theta/3r$, where c is the loss by conduction, and r the loss by radiation. Experiment shows that for T = 1500° K, $d\theta = +100°$, two filaments of length 5 cm., and diameters 0·06 and 0·35 mm., dT was + 3° and + 24° respectively. The effect of alteration in the external temperature when the resistance or the voltage is kept constant is also discussed and experimentally verified. T. B.

1393. *The Accurate Measurement of Heats of Vaporisation of Liquids.* **J. H. Mathews.** (Am. Chem. Soc., J. 48. pp. 562–576, March, 1926.)—The methods available for the determination of heats of vaporisation are of two general classes, (1) condensation methods, (2) evaporation methods. The author has chosen the latter as being more accurate and involving a less number of corrections, such as that required for the heat given out by the condensed liquid cooling from the boiling temperature to that of the calorimeter. The liquid is boiled by means of an electrical heater in a small "vaporiser" suspended in an atmosphere of the vapour. The loss of weight of the liquid is directly determined by suspending the vaporiser from one arm of a balance. The amount of heat required to convert this weighed quantity of liquid to vapour at the same temperature is given by R × T × $I^2/4{\cdot}186$, where R is the resistance of the heating wire, I the current through it for a time T. The order of accuracy is claimed to be 0·1 cal. or less. The heats of evaporation of fifty-nine liquids have been measured by this method, and for a number of these liquids values have not heretofore appeared in the literature. The value obtained for benzene is 94·35 ± 0·03 cal. per gramme at a temperature 80·2° C. Calculations of heats of vaporisation of some of the liquids are also made from vapour-pressure data, but values obtained in this way are not considered to be so reliable as those obtained by the author's direct method. T. B.

1394. *Vapour-Pressures of Solid and Liquid Hydrogen Cyanide.* **J. H. Perry** and **F. Porter.** (Am. Chem. Soc., J. 48. pp. 299–302, Feb., 1926.) —The results are given of measurements of the vapour-pressures of hydrogen cyanide from − 30·4° to the triple point for the solid and from the triple point to + 27·32° for the liquid. The equations derived from the experimental data are $\log_{10} P(\text{mm.}) = 9{\cdot}33902 - 1864{\cdot}8/T$ and $\log_{10} P(\text{mm.}) = 7{\cdot}744603 - 1453{\cdot}063/T$ for the solid and liquid respectively. The triple point of hydrogen cyanide is calculated to be 658·24° K or − 14·86° C. at the vapour-pressure 131·16 mm.; the normal boiling-point is 298·75° K or + 25·65° C. The latent heats of sublimation, fusion and evaporation are respectively 316·13, 69·29, and 246·84 cals. per gramme. T. H. P.

1395. *Adjusted Vapour-Pressures of Zinc and Cadmium.* **C. G. Maier.** (Am. Chem. Soc., J. 48. pp. 356–364, Feb., 1926.)—Selected data for the vapour-pressures of Zn and Cd are critically recalculated in order to express the experimental values consistently for thermodynamic calculations. On the assumption that Zn and Cd vapours are perfect monatomic gases, standard free-energy equations are derived for volatilisation, sublimation and fusion. A. B. C. L.

1396. *The Vapour-Pressure of Arsenic Trioxide.* **E. R. Rushton** and **F. Daniels.** (Am. Chem. Soc., J. 48. pp. 384–389, Feb., 1926.)—Measurements of the vapour-pressure of arsenic trioxide up to 500° are recorded as the results of experimental work. The thermostat used was an electrically-heated iron vessel filled with tin and lead in suitable proportions and heavily lagged with asbestos. The bath could be heated up to 800° C. The Gibson diaphragm was used, and all experimental precautions are given. The vapour-pressures of octahedral and liquid arsenic trioxide were measured and the equations corresponding thereto determined. The vapour-pressure of monoclinic arsenic trioxide was estimated. For octahedral arsenic trioxide the melting-point is given as 275° C., and for the monoclinic form approximately 315° C. The regions of stability of the various allotropic forms are determined, the influence of the time variable discussed, and the heats of vaporisation, fusion and transition calculated. S. G. B.

1397. *Determination of the Vapour-Pressures of Mercury, Cadmium and Zinc by a Modified Manometric Method.* **C. H. M. Jenkins.** (Roy. Soc., Proc. 110. pp. 456–463, Feb. 1, 1926.)—In the method used for measuring the vapour-pressure, the substance under examination is used as the liquid in the manometer, which is employed to indicate a balance between the vapour-pressure of the substance and a pressure of nitrogen applied externally. The measurement is made by statical means, the vapour being in contact with a free surface of the liquid; hence superheating is avoided. For the determinations on mercury the manometer was of glass, but for measurements above 500°, as with cadmium and zinc, fused silica apparatus was used. Owing to possible absorption of metal by small cavities in the silica walls, a new apparatus was employed for each measurement. The manometer is heated by means of a silica-tube furnace with a nichrome wire winding, the temperature being measured by a platinum platinum-rhodium thermocouple just immersed in the liquid. The accuracy of the pressure readings is about 2 mm., and that of the temperature about 1° at 600°. If suitable precautions are taken to guard against alterations in composition, or to check the latter, the apparatus affords a means of determining the total vapour-pressures of molten alloys. The comparatively large alterations in pressure produced by small alterations in temperature provide a basis for constructing a vapour-pressure thermometer capable of measuring small variations in high temperatures. T. H. P.

1398. *Contributions to the Theory of Heat Convection.* **B. Gündel.** (Ann. d. Physik, 78. 8. pp. 697–742, Jan., 1926.)—The paper deals with the flow of fluid which results from varying density due to a definite distribution of temperature under the influence of gravity. The paper is entirely a mathematical one, in which the author, after mentioning the chief papers which have appeared dealing with the cooling of a hot body in a flowing fluid, and stating the limitations to which they were subjected, attempts to solve the most general hydrodynamical equation dealing with the problem in hand. The paper is unsuitable for a short abstract.
T. B.

1399. *The Rare Gases of the Atmosphere.* **E. Rutherford.** (Engineering, 121. pp. 353–354, March 19; 388–390, March 26; 438, April 2, and pp. 458–459, April 9, 1926. Lectures delivered before the Roy. Inst., March, 1926.)—The historical experiments which led up to the discovery and separation of the rare gases, argon, helium, neon, krypton and xenon are described. The uses of argon in gas-filled lamps, of neon in illuminating signs and as a detector of over-voltage, and the possible use of xenon when testing X-rays are explained and the atomic properties of each of these five gases are tabulated. Finally the discovery and examination of the three emanations—radon, thoron and actinon—were dealt with from the historical standpoint and their radio-active properties examined. R. S. R.

1400. *The Effect of the Presence of an Indifferent Gas on the Concentration and Activity of a Vapour in Equilibrium with a Condensed Phase or System of Condensed Phases.* **I. R. McHaffie.** (Phil. Mag. 1. pp. 561–583, March, 1926.)—It is shown thermodynamically that the relative activity coefficient f_P at pressure P can be obtained when from the experimental data c_P the concentration is known, the equation deduced being

$$\log f_P = PV_S/RT + \log C_0 - \log C_P$$

In this equation C_0 is the concentration of vapour in some standard state, V_S the molar volume of the solid (or liquid) substance with which the vapour and the indifferent gas are in contact. The concentration of water in the gas phase in equilibrium with $Na_2SO_4 . 10H_2O$ and Na_2SO_4 has been determined by the author in the presence of air up to a pressure of 100 atmos. The data of Pollitzer and Strebel [see Abstract 2545 (1924)] are used for the calculation of the relative activity coefficient for water-vapour in equilibrium with liquid water at 50° C., and in the presence of air up to a pressure of 200 kg. per sq. cm. Finally, the relative activity coefficient for water-vapour in equilibrium with $Na_2SO_4 . 10H_2O - Na_2SO_4$ at 25° C. is calculated, assuming that the effect observed is entirely due to the deviation of water-vapour from ideal gas behaviour as a result of the increasing density of the indifferent gas. T. B.

1401. *The Einstein Gas Theory.* **E. Schrödinger.** (Phys. Zeits. 27. pp. 95–101, March 1, 1926.)—The precise meaning of the Einstein gas theory is that a gas can be considered as a system of separate linear vibrations, similar to those of a solid body or in a radiation volume. The analogy is explained. The experimental work of Bose, de Broglie, Jeans and Debye are utilised to illustrate the arguments, which are mathematical and theoretical throughout. S. G. B.

1402. *The Liquefaction of Gas and the Properties of Fluids at Low Temperatures.* **A. Schlidlof.** (Arch. des Sciences, 8. pp. 5–22, Jan.–Feb., 1926.)—In a previous paper the author employed Bose's statistical method based on the idea of the quantum of light to establish Planck's radiation law. This method is now employed to find the limits of validity of the classical law of energy distribution in the case of a perfect monatomic gas. The theory is extended to the derivation of the expression for the entropy of a gas as a function of only one characteristic variable. The equations are deduced for gases in states of degeneration and also for fluids at low temperatures. From these the properties of fluids in such states are ascertained. The theory is finally applied to the thermodynamical properties of liquid helium. The arguments are theoretical throughout. S. G. B.

1403. *An Experimental Test of the Deformation of the Atoms of Monatomic Gases.* **W. Meissner.** (Zeits. f. Physik, 36. 5. pp. 325–335, 1926. From the Reichsanstalt.)—The author has previously shown that the results obtained in liquefying helium indicate deviations from the law of corresponding states, which can possibly be explained as quantum effects, and has compared the experimental results with the new theories of Einstein and Planck. In the present paper he gives a more extended treatment of the above questions, dealing with the liquefaction of helium by Linde's process, and assuming that the process takes place adiabatically in the lower part of the apparatus, he obtains an expression for ϵ the liquefied fraction of the gas passing through it in terms of the pressure specific volume and specific energy of the gas at certain definite points in the apparatus, and of the heat of vaporisation of the liquid helium; he has also found experimentally a value of ϵ for certain definite conditions in the apparatus, which, since the conditions are not really adiabatic, gives a lower limiting value for ϵ. A calculation of ϵ for helium, using the law of corresponding states, and supposing it to behave like air, gives a value which is only about a quarter of that determined experimentally. It is shown that the Nernst theory of atomic deformation gives in one form a negative value for ϵ, and in another a vanishingly small value, while the Einstein theory gives a positive value, the magnitude of which, however, is not sufficient to explain the difference between the observed value and that calculated by means of the law of corresponding states; the same is true of Planck's theory. The relation between the specific heat of the gas and the theory of deformation (*Entartung*) is also considered. H. N. A.

1404. *Theory of the Shaft Furnace.* **H. le Chatelier.** (Comptes Rendus, 182. pp. 735–739, March 22, 1926.)—Deals with the theory of the shaft furnace, treating it as a vertical cylinder at the top of which the solid matter to be treated is continuously introduced, whilst the hot gases enter continuously at the bottom, the aim being to determine the temperature of exit of the products. W. H. Ge.

1405. *The Pressure Dependence of Atomic Oscillation Frequencies in Elementary Solid Bodies.* **F. I. G. Rawlins.** (Zeits. f. Physik, 36. 5. p. 400, 1926.)—This paper contains a discussion of a recent publication by Sirk [see Abstract 129 (1926)]. It is pointed out that the agreement between the values for ν (thermal) and ν (Lindemann) is very irregular, and stands only in a loose relationship to the crystal properties. Deviation occurs usually for elements of high melting-point. In general, ν (thermal) is $>$ ν (Lindemann), and it is indicated that the Grüneisen and Lindemann hypotheses never lead to equations which are completely in agreement. H. H. Ho.

1406. *The Excess Temperature of an Isolated Black Sphere.* **F. Linke.** (Meteorolog. Zeits. 43. pp. 11–15, Jan., 1926.)—At the Taunus Observatory registrations have been made since July, 1925, with a black sphere actinometer, consisting of a hollow copper sphere 4·44 cm. in diameter and 0·5 mm. thick, containing the sutures of twenty-four manganin-constantan thermoelements, of which the other sutures are kept at atmospheric temperature in a thermometer shelter. The sphere, thermally isolated with vulcanite, is about 1 metre above the roof of the thermometer shed, which is 1½ metres high. The registration is made with a Hartmann and Braun duplex recording voltmeter, on which at the same time the intensity of the direct solar radiation is recorded by a Hartmann and Braun universal actinometer, the thermometer battery of which consists also of manganin-constantan thermoelements having no temperature coefficient. As the actinometric difference (temperature of the black sphere minus air temperature) depends on the force of the wind, the wind velocity is registered close beside the sphere. The object of the apparatus is to ascertain the total effect of all the radiative processes acting on the sphere—direct solar, sky, terrestrial radiation and radiation from the sphere itself. By excess temperature is understood the excess of the black sphere temperature over that of the air. The measurements obtained are mathematically worked out and tabulated. E. F.

1407. *Effect of High Pressure on the Properties of the Alkali Metals.* **P. W. Bridgman.** (Phys. Rev. 27. pp. 68–86, Jan., 1926.)—A comparative study is made of the melting data, electric resistances, and compressibilities, published elsewhere, of the alkali metals under high pressures. Whereas at low pressures the melting-point increases with decreasing atomic weight, the order of the melting-points tends to be reversed at high pressures. Except in the case of Li, which is anomalous, the latent heat of melting and the fractional change of volume on melting are roughly the same, per gramme-atom, for each metal. The electrical resistivity of Cs passes through a minimum at a pressure of 4000 kg./cm.^{2}, and it is suspected that the other metals may have minima at pressures outside the range investigated. As regards density, the volume per electron is of the same order for each of the alkali metals, whereas the volumes per atom show greater differences. The volume per electron increases with decreasing atomic weight, except that at low pressures K is anomalous. The compressibilities per electron are of the same order at high pressures, that of K being, however, anomalously high. The results are compared with those for a perfect gas, consisting of electrons, under high internal pressure, and it is suggested that at extreme pressures the quantum orbits of the atoms break down. C. W. H.

1408. *Total Radiation and Specific Resistance of Tungsten at Incandescence.* **W. Geiss.** (Ann. d. Physik, 79. 1. pp. 85–88, Feb., 1926.)—The measurements were made on non-sag wire of Philips' manufacture. The length was 90 cm. and diameter 101·7 μ. The potential terminals were also of tungsten, and 20 μ in diameter. The wire was suitably mounted in a long glass tube, which could be highly exhausted. The current and potential difference were measured, and the watts η per unit of surface were calculated, as well as the specific resistance ρ. The relation $\eta = 1{\cdot}425 + 10^{-6} . \rho^{4.14}$ was found to hold between 1700° and 2700° K. This is in very close agreement with the results of Zwikker and the unpublished results of Holst and Oosterhuis, but differ by a constant from those of Forsythe and Worthing. T. B.

1409. *The Absolute Constant of Entropy and its Applications.* **F. Rasetti.** (N. Cimento, 3. pp. 67–86, Jan.–Feb., 1926.)—In the course of a mathematical dissertation the author reaches the following conclusions: A chemical equilibrium cannot be completely calculated from measurements of the energy of reaction by means of classical thermodynamics. Calculating the entropy of a perfect monoatomic gas by means of statistical mechanics we obtain a value containing an arbitrary constant. Introducing a quantic hypothesis, we are able to determine an absolute value of entropy. The absolute constant of entropy of gases is the basis of the determination of the vapour tension of a solid or of a liquid, but here another element intervenes, which is not given by classical thermodynamics, *i.e.* the absolute value of the entropy of the condensed system. This is supplied by Nernst's principle, fixing it at nil at absolute zero. Admitting this principle, the value of the constant of entropy of a perfect monoatomic gas can be found with Stern's theory. The few cases which admit of an experimental verification of the theories advanced confirm them completely. An examination of the relations existing between the quantic states of the atom and the constant of entropy of a gas shows clearly that a precise theoretical determination of the constant of entropy for polyatomic molecules is impossible till our knowledge of their quantic states—*i.e.* of their band-spectra—is more exact. This all constitutes undoubtedly one of the most notable examples of the close connection revealed by the light of modern quantic theories between domains of physics at first thought to be absolutely independent, such as the thermodynamic properties of vapours and the spectroscopy of the atom. A bibliography is appended. E. F.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

1410. *Einstein's Recent Theory of Gravitation and Electricity.* **L. P. Eisenhart.** (Nat. Acad. Sci., Proc. 12. pp. 125–129, Feb., 1926.)—The equations of Einstein's recent theory of the gravitational and electromagnetic fields [see Abstract 141 (1926)] are deduced by assuming that a certain integral is stationary for variations of a covariant tensor density of the second order and the coefficient of an asymmetrical connection. The nature of this connection is more particularly defined, and the equations which in this new theory replace Maxwell's equations are derived in tensor form. J. S. G. T.

1411. *Flux in a Circular Circuit.* **C. Hering.** (Am. I.E.E., J. 45. p. 123, Feb., 1926.)—A short article showing that calculations over a wide range of values strongly indicate that the total flux in a single-turn circular circuit is probably exactly equal to that around a single conductor up to a radial distance equal to the radius of the circle and for a length equal to its circumference, the size of the wire being the same. The latter is easily calculated exactly, whereas the calculation of the former is extremely tedious, involving elliptical integrals unless based on the self-inductance formulæ, and then it is only approximate. If found to be rigidly true, it shows one of the advantages of starting with the single conductor as the fundamental. AUTHOR.

1412. *Energy of a Straight Current.* **C. Hering.** (Am. J. Sci. 11. p. 174, Feb., 1926.)—A brief reply to the alleged claims of L. Page [Abstract 345 (1926)] that the present author was in error. Reference is made to a further and more detailed discussion of this subject [Abstracts 346 and 571 (1926)], in which the explanations are given why these results differ from our former beliefs, the chief one being that formerly the energy of components had been added to that of their resultant. Page had pointed out no error in the proofs, but merely gets a different result, based on infinities and zeros, by assuming such curiosities as two currents flowing simultaneously in opposite directions in the same conductor of zero cross-section. His alleged proof is based essentially on the effects of the return conductor, which by definition must be negligible in the true single conductor. His experiment, however, demonstrates the existence of the much-disputed longitudinal force in a conductor. AUTHOR.

1413. *A Single Straight Conductor as a New Fundamental. A Rejoinder.* **L. Page.** (Frank. Inst., J. 201. pp. 245–246, Feb., 1926.)—Calculations and an experiment to show that certain results obtained by C. Hering [see Abstracts 690 B (1925) and 346 (1926)] are erroneous.

1414. *Single Straight Conductor.* **C. Hering.** (Frank. Inst., J. 201 p. 497, April, 1926.)—A brief reply to the allegations of L. Page [see preceding Abstract], whose experiment and calculations both involve the return conductor as an essential factor and thus do no apply at all to the single conductor, the very characteristic of which is that the effect of the return conductor is negligible. AUTHOR.

1415. *Propagation of Stationary Electric Currents under the Action of a Magnetic Field.* **Elena Freda.** (Accad. Lincei, Atti, 3. pp. 77–82, Jan. 17, 1926.)—A mathematical discussion of the subject, starting from equations based upon the electronic theory of Drude for the propagation of stationary electric currents in a homogeneous and isotropic conductor placed in a uniform magnetic field. A. E. G.

1416. *Electrification of Two Intersecting Planes.* **W. B. Morton.** (Phil. Mag. 1. pp. 337–348, Feb., 1926.)—The two-dimensional problem of finite breadth, but of infinite length in the direction of their intersection, is solved by Schwarz's method of conformal representation. The differential equation expressing the transformation is found to be integrable, so that the coordinates of a point in the electric field can be simply expressed in terms of the logarithmic potential and the line of force function. With reference to the distribution of the charge, it is shown that half of the entire charge is borne on the outer side of one plane together with the inner side of the other. When the two planes have equal breadths and are inclined at angle $(\pi - \gamma)$ the charge on the convex side is to that on the concave side in the ratio of $\frac{1}{2}\pi + \sin^{-1}(\gamma/\pi)$ to $\frac{1}{2}\pi - \sin^{-1}(\gamma/\pi)$. When the planes are equal and at right angles the outer charge is double the inner. A. B. C. L.

1417. *The Earth's Electrical Charge.* **T. Schlomka.** (Ann. d. Physik, 78. 2. pp. 204–208, Nov., 1925.)—The author criticises Ramsauer's method of determining the earth's electrical charge [Abstract 635 (1925)]. The main point raised concerns "the neutral atom state," which Ramsauer considers enables an absolute value to be given to the earth-charge. The author considers that this is an error, and moreover that the experimental possibility of determining the "neutral atom state" in no wise follows from the definition of atomic neutrality. W. A. R.

1418. *The Earth's Electrical Charge.* **C. Ramsauer.** (Ann. d. Physik, 79. 1. pp. 89–93, Feb., 1926.)—The author defends his method of determining the earth's electrical charge [Abstract 635 (1925)] against criticism by Schlomka [see preceding Abstract]. W. A. R.

1419. *Sunspot and Annual Variations of Atmospheric Electricity, with Special Reference to the Carnegie Observations,* 1915–1921. **L. A. Bauer.** (Dept. of Terrest. Magnetism, Researches, 5. pp. 359–384, Jan., 1926.)

1420. *Studies in Atmospheric Electricity based on Observations made on the Carnegie,* 1915–1921. **S. J. Mauchly.** (Dept. of Terrest. Magnetism, Researches, 5. pp. 385–424, Jan., 1926.)

DISCHARGE AND OSCILLATIONS.

1421. *Phenomena at the Kathode of the Arc Discharge.* **R. Seeliger.** (Phys. Zeits. 27. pp. 22–41, Jan. 1, 1926.)—The subject is dealt with at some length along the following lines: The different forms and the definition of the arc discharge; qualitative theory of the kathode fall; the current distribution at the kathode; the burning spot; difficulties in the way of the thermic arc theory. A useful list of papers on the subject is appended. A. E. G.

1422. *Stability Conditions of the Arc Light and Electron Tubes.* **H. Barkhausen.** (Phys. Zeits. 27. pp. 43–46, Jan. 15, 1926. Abstract of paper read before the Deut. Phys. Gesell., Halle, Nov. 18, 1925.)—Arc lights and electron tubes behave in a completely opposite manner with respect to their stability towards direct currents as towards alternating current. All elements in the circuit which increase the stability with the arc light diminish it with the tube, and inversely. Physically the difference lies in the fact that with the arc light an alteration of the tension is produced by an alteration in the current, while inversely, with the tube the current alteration is produced by an alteration of the tension. Mathematically the arc light is considered as an induction and the tube as a capacity. A. E. G.

1423. *The Transition from Glow to Arc Discharge at Atmospheric Pressure.* **J. Slepian.** (Frank. Inst., J. 201. pp. 79–90, Jan., 1926.)—In glow discharge (current density a few amp./cm.^{2}, cold kathode) the electrons present are presumed to be derived from ionisation by impact of positive ions on the kathode or adjacent gas, while in the case of arc discharge (current density 100 or 1000 times as great, hot kathode) they are attributed to thermionic emission from the kathode. The sudden transition from glow to arc has been explained by Stark as due to rise in temperature of the centre of the kathodic spot as the current increases, but in the present paper this explanation is found to be unsatisfactory when quantitatively tested by data which are partly experimental and partly based on reasonable assumptions. Thus, the critical glow current at which the transition takes place is found to be too small to produce the required temperature. In the case where the arc is started by a disruptive discharge between cold electrodes, the time required for the kathode to reach thermionic-emission temperature is found by calculation to be substantially greater than the time actually taken to start an arc by the discharge of a condenser whose rate of discharge is known. The view now put forward is that the transition from glow to arc is due to thermal ionisation of the gas in the dark space, on the side of the latter remote from the kathode, the cooling of this gas by the kathode being hindered by the low thermal conductivity of the gas. It is shown that this view is free from the quantitative objections urged against that of Stark. C. W. H.

1424. *The Relation between Minimum Sparking Potential and Temperature.* **E. F. Burton.** (Phil. Mag. 1. pp. 219–224, Jan., 1926.)—Two cylindrical brass electrodes are enclosed in a quartz tube and subjected to a known potential difference; the gas-pressure is then reduced till sparking occurs, and further reduced until sparking ceases. By gradually lowering the p.d. a value of the latter can be found where the pressures for sparking and extinction coincide, no spark being obtainable below this p.d. whatever the pressure. The apparatus is immersed in a bath of glycerine or ether, and the minimum sparking potential is measured as above at eight temperatures ranging from − 190° C. to 200° C., the gas used being purified air. The potential/temperature curve is roughly parallel with the density/temperature curve. C. W. H.

1425. *Electric Discharge Figures on Photographic Plates.* **K. Gorbatscheff.** (Phys. Zeits. 27. pp. 79–84, Feb. 1, 1926.)—The negative figures here described differ in form and dimensions from the usual negative figure. The positive discharge figures are nearly the same for both cold and glowing poles in form and structure, but different in dimensions. Negative figures obtained through an ebonite plate with cold and with glowing poles differ in form, size, and structure approximately the same as those obtained without the ebonite plate. The positive figures obtained simultaneously through an ebonite plate differ in structure. [See Abstract 1092 (1920).] A. E. G.

1426. *Theory of the Three-point Spark-Gap.* **C. E. Wynn Williams.** (Phil. Mag. 1. pp. 353–378, Feb., 1926.)—When the p.d. between two electrodes is just insufficient to give a spark, the spark can be induced by the proximity of a third electrode which may be connected to one of the others or may be insulated. It is found that this "three-point effect" is obtained when either (*a*) a silent discharge or (*b*) a pilot spark occurs within a limited distance of the main gap, and in such a position as to be "visible" or unscreened from the gap, as distinct from the electrodes. Case (*a*) is investigated by means of a needle connected by a wire to one of the main electrodes, case (*b*) by means of a pilot spark-gap; similar results, differing in intensity, are obtained in the two cases. The effect can be inhibited by the interposition of any screen in a straight line between the needle-point and the main gap except a screen of celluloid consisting of a film thin enough to give interference patterns, which fails to interfere with the effect. Three possible explanations of the phenomenon are considered: (1) Distortion of the electric field in the neighbourhood of the main spark-gap; (2) formation of ions by the silent discharge or by the pilot spark; (3) radiation from the discharge or spark. Explanations (1) and (2) are ruled out by the results of experiments in which gauze and other screens are variously arranged, and explanation (3) is adopted. It is found that the radiation is diffusely reflected by glass, quartz, metal, paper, etc.; ionises the air through which it passes, particularly in the presence of turpentine vapour; does not act on the main gap by means of the photoelectric effect (although in the case of the pilot spark the photoelectric action of ultra-violet radiation plays a part in the three-point effect); penetrates several cm. of air and passes through a thin celluloid film, but not through any other of the screens which were used. These properties indicate that the radiation must lie somewhere in the little known range from 13 Å. to 1000 Å., in which Wiedemann's "Entladungsstrahlen" are known to lie; they were therefore tested for the property of thermoluminescence. This property was found in the case of radiation from the pilot spark, but not of that generated by the silent discharge from the needle-point. The conclusions are reached that (1) the "Entladungsstrahlen" are produced in air at ordinary pressure by silent discharge as well as by spark, and (2) the three-point effect affords a sensitive test for these rays. C. W. H.

1427. *Theory of "Glow" Protective Devices.* **F. Kesselring.** (Archiv f. Elektrot. 15. pp. 443–465, Feb. 6, and pp. 491–508, Feb. 22, 1926.)—A comprehensive treatment is given relative to protective devices of the "glow" type in which two conductors are used, the lower being shielded by a flat-topped glass bell and an air space intervening between this and the upper conductor. Both conductors are usually made up of a series of sharp-edged leaves, the planes of the upper set being at right angles to those of the lower. Such devices are first considered in quasi-stationary circuits. The resistance of ionised air, glow and spark discharges are discussed, and general considerations relative to the calculation of the variable resistance of the ionised air are given. The effect of surges is considered, and a comparison is made of the glow-type of protector with other types. Theoretical and experimental data relating to the steepness of surge wave-fronts are presented, and in a subsequent paper it will be shown in what way and to what extent the maximum steepness of such wave-fronts can be reduced by the use of protectors of the glow type.

A. W.

1428. *Gas Flow and Pressure Changes in Gases under Electric Discharge.* **R. G. Lunnon.** (Phil. Mag. 1. pp. 482–491, Feb., 1926.)—The experiments described in this paper were made to measure the viscosity of gases whilst an electric discharge is passing through them. The work was undertaken because of the possibility that, while the excited atoms are radiating energy, their electron orbits may be enlarged and the consequent increase in the effective size of the atom may tend to reduce the viscosity. No evidence, however, has been found of such a change, which may probably be too small for measurement by reason of the small number of excited atoms. Apparatus and experimental details are given for measurement of the flow of gases in fine capillary tubes at low pressures. The rate of flow was found to be unaffected to within less than 5 % by an electric discharge passing through the flowing gas. A theoretical discussion, however, indicates that an effect may be expected with diatomic gases at very low pressures. Observations have also been made of the disappearance and emission of gas in discharge-tubes. The flow experiments were made with chemically pure nitrogen, commercial oxygen, air, and a mixture of 75 % argon with 25 % nitrogen and a trace of oxygen, very complete data being recorded. H. H. Ho.

1429. *Space Charge Currents between Coaxial Cylinders in the Presence of a Gas.* **W. H. McCurdy.** (Phys. Rev. 27. pp. 157–162, Feb., 1926.)—Langmuir has derived an equation for the space charge limited current between coaxial cylindrical electrodes in high vacuum. In this paper Compton's equation for the terminal velocity of an ion suffering elastic collisions in an electric field [see Abstract 593 (1924)] is applied to the case of space charge currents with gas present. Assuming the pressure sufficient so that the ions reach nearly the terminal velocity, and neglecting the contribution of thermal agitation to the velocities of the ions, the following approximate equation is derived: $i = \mathrm{A}\sqrt{l\mathrm{V}^3/(a\mathrm{B})^3}$, where l is the mean free path, V is the voltage, a is the radius of the outer cylinder, B is a function of the ratio of the two radii (values are given in a table), and A is a constant depending on the charge and mass of the ions.

AUTHOR.

1430. *Low-voltage Discharges in Helium.* **W. H. McCurdy** and **P. Dalton.** (Phys. Rev. 27. pp. 163–172, Feb., 1926.)—A hot filament kathode and disc anode were mounted in a glass frame 10 to 12 cm. apart, the frame being so arranged that it could be moved magnetically inside a glass tube of diameter about 4 cm. with reference to a fixed exploring electrode. Measurements of potential distribution and of mean energy and concentration of electrons were made at three pressures, 0·095, 0·5 and 2·9 mm. Although precautions were taken to secure pure He, striations were obtained because of a trace of neon. The results are similar to those obtained by Bramley for hydrogen [Abstract 815 (1926)]. The mean electron energy decreases to a minimum beyond the negative glow, then rises to a maximum beyond the face of the first striation. The electron concentration falls from a maximum in the negative glow to a minimum near the kathode side of the first striation; within the limits of accuracy of the work, it increases in a given region of the discharge with an increase of pressure and is proportional to the current density of the discharge at a given pressure. Calculations of the positive ion concentrations by Langmuir's formula, and also by one developed by McCurdy, give results which seem to be equal to the electron concentrations, but as both methods are merely approximations, this result is not very reliable. AUTHORS.

1431. *Free Path of Protons in Helium.* **A. J. Dempster.** (Nat. Acad. Sci., Proc. 12. pp. 96–98, Feb., 1926.)—In a former paper [see Abstract 159 (1926)] the author has described experiments with protons that had been accelerated through 900 volts p.d. The particles were found to have a much longer free path in hydrogen than would be expected from Rüchardt's observation with faster rays (13,000 to 16,000 volts). These experiments have since been extended to pressures five times as great as previously used, with similar results. The conclusion arrived at is that protons with velocities used in these experiments will pass freely through atoms of helium, with only slight changes in their velocity or direction. A. E. G.

1432. *The Universal Constant of Thermionic Emission.* **P. W. Bridgman.** (Phys. Rev. 27. pp. 173–180, Feb., 1926.)—The constant A of the thermionic emission formula $I = AT^2e^{-b_0/T}$ has been shown by Richardson and Dushman by different lines of argument to be a universal constant, and a value for the constant has been deduced by Dushman. The experimental data of Dushman verify this value of A for pure metals, but if the metal is coated there are very wide divergences. In this paper an attempt is made to give a more rigorous deduction of the emission formula, so that it may be plain under what conditions it may be expected that A be universal. Assuming that the entropy of the electron gas is the same as that of an ordinary monatomic gas in the Sackur Tetrode theory, and also assuming that the entropy of a surface charge is zero at 0° abs., it is shown that an emission formula of the type above necessarily demands that A have the universal value assigned by Dushman, and the necessary and sufficient condition for this is that the difference between the specific heat of the neutral metal and of a charge on its surface vanish ($C_{pm} - C_{pp} = 0$). This condition may also be formulated in terms of the surface heat and is equivalent to $\sigma + dP_s/dT - P_s/T = 0$, where P_s is the surface heat and σ the Thomson heat. If σ can be neglected, the emission formula holds with the form given when P_s is proportional to absolute temperature. Physically it seems probable that (1) if the metal is uncoated the forces on the surface ions are nearly the same as on the neutral atoms, so that the condition $C_{pm} - C_{pp} = 0$ is satisfied; but (2) if the surface charge has the properties of a gas, as in an oxygen-coated filament, (*a*) the specific heat may be different from that of the metal, or more probably (*b*) the entropy of the surface charge may not vanish at 0° abs.; and (3) if the surface is coated with another more easily ionisable metal there may be electrical forces on the surface ions which modify their specific heat. **AUTHOR.**

1433. *The So-called Positive Photoelectric Emission (Inverse Effect) and the Reality of the Sub-electron.* **E. J. Lorenz.** (Phil. Mag. 1. pp. 499–509, Feb., 1926.)—A few observers have reported the discharge of positive electricity produced by ultra-violet light. Dember [see Abstract 1736 (1909)] found that a metal plate exposed to ultra-violet light *in vacuo* had the power to communicate a positive charge to a receiving cylinder when the proper accelerating field was applied. His experiments have recently been repeated by du Bridge, who reports that Dember's results can be entirely accounted for on the basis of the photoelectric effect produced on the collecting cylinder by scattered ultra-violet light against which no precautions had been taken. R. Bär and F. Luchsinger, working with small particles of paraffin and selenium in a Millikan electron apparatus, found that some of the particles showed the inverse effect. S. Taubes reported this inverse effect when dealing with particles that had a large positive charge, and showed that it is due to the photoelectrons given off by the condenser plates, for when these were coated with paraffin the inverse effect entirely disappeared. M. Hake has recently reported results on nineteen different materials. He found that metals show both the inverse and the normal effect, depending on the gas in which the metal particles are suspended, and that some insulations—for example glycerine—always show the inverse effect in all gases. Wasser gives results on mercury drops in N and CO_2. He claims that drops of larger radius than $1 \cdot 9 \times 10^{-5}$ always show the normal effect, that those between $1 \cdot 1$ and $1 \cdot 9 \times 10^{-5}$ cm. show both the normal and the inverse effect, while those of smaller radius than $1 \cdot 1 \times 10^{-5}$ cm. always show the inverse effect. The investigations here described are undertaken to test the correctness of the above conclusions and to determine whether the changes in charge experienced by minute mercury droplets are of a magnitude corresponding to the electronic charge or to a charge smaller than this. It is claimed that the inverse photoelectric effect is a spurious effect, and is not due to discharge of positive electricity. This has been proved by careful work on oil, glycerine, and mercury drops in various gases. Work with mercury drops shows that the drops that yield values of e smaller than $4 \cdot 77 \times 10^{-10}$ e.s.u. also show an abnormal behaviour to ultra-violet light—that is, they are only slightly sensitive or not sensitive at all. The multiple relationship holds for the charges on these insensitive drops, proving that their charges are electronic, and that it is erroneous to assume their density to be that of mercury. Drops that are known to be pure mercury satisfy Millikan's $e_1^{2/3}$, $1/pa$ relation, and yield $4 \cdot 77 \times 10^{-10}$ e.s.u. for the electronic charge, and $0 \cdot 695$ as the value of the correction constant, A, in Stokes' law. A. E. G.

1434. *Mobility of Ions in Air. Part I. Negative Ions in Moist Air.* **A. M. Tyndall** and **G. C. Grindley.** (Roy. Soc., Proc. 110. pp. 341–358, Feb. 1, 1926.)—In the case of negative ions in air, with which the present paper deals, there is a wide disagreement between the values obtained for the mobility by different observers, and it is disputed whether the ions are all of the same mobility or are distributed in groups of several different mobilities. Most of the more recent work has been carried out with some modification of the original alternating field method of Rutherford, the appropriate sign of ions being introduced through a gauze into the main chamber by an auxiliary field. Loeb obtained the value 2·20 for the mobility of the negative ion in dry air which, although higher than the mean of earlier values obtained, is in agreement with a previous value of his, 2·18, obtained without a gauze by generating the ions directly in the chamber by ultra-violet light. The view that the ions consist of a mixture of groups of different mobilities has been put forward by Nolan, who claims that the curves obtained by the alternating field method show a number of "breaks" or "kinks," each of which corresponds to a distinct group. Loeb, however, does not consider that the accuracy of the experimental points justifies this treatment. All observers agree that the effect of water-vapour is to reduce the average mobility of the ions. In the present paper an improved absolute method of measuring the mobility of ions in air at atmospheric pressure is described and applied to negative ions. The method depends upon the production of ions by a series of flashes of α-rays and subjection to an alternating field of a special kind. The conditions are so arranged that when the current arriving at an electrometer is plotted with frequency of the alternating field a curve with a sharp peak is obtained, the position of which gives an accurate measurement of the mobility. The method gives the mobility of fully formed negative ions, since the results are not influenced by ions which preserve their electronic state after birth for any appreciable portion of their path in the field. The effect of water-vapour on the mobility of negative ions has been studied over a wide range of humidity. In reasonably, though not exceedingly, dry air the value obtained for the mobility is 2·15 cm./sec./volt/cm. in fields from 50 to 200 volts/cm. This is higher than that of earlier investigators, but is in agreement with Loeb's more recent value. With the addition of water-vapour the mobility falls rapidly at first and then more slowly to the value 1·60 in saturated air. The absence of subsidiary peaks in the curve shows that at any rate the great majority of the ions are of one kind. No other groups were detectable with the resolving power and range of frequency available.

A. E. G.

1435. *Mobility of Ions in Air. Part II. Positive Ions of Short Age.* **A. M. Tyndall** and **G. C. Grindley.** (Roy. Soc., Proc. 110. pp. 358–364, Feb. 1, 1926.)—The method of the previous paper (see preceding Abstract) is applied to the measurement of the mobility of positive ions of short age. Definite evidence is found of the existence of two types of positive ions, an initial ion and a final ion. The initial positive ion has a mobility which is indistinguishable from that of a negative ion, and which is affected by water-vapour in the same way. These results are in agreement with the work of Erikson by another method. The authors find, however, that the presence of water-vapour has a retarding influence upon the rate of transformation into final ions. Thus in ordinary dry air a considerable amount of transformation is noticeable within 0·007 sec. of birth, but in wet air the ions are still nearly all in their initial state at double that age. These conclusions are confirmed by a modification of the apparatus which converts the method into one of the Langevin type. Theoretical discussion is postponed until more experimental data are available. A. E. G.

1436. *Interference Experiments on Canal-Rays.* **E. Rupp.** (Ann. d. Physik, 79. 1. pp. 1–34, Feb., 1926.)—Hydrogen and mercury canal-rays are here experimented upon by means of the Michelson interferometer. The electrical part and the optical part of the arrangement used is described in detail with diagrams. The vanishing of the interference strips is dealt with on the grounds of the spectral structure of the lines and also with reference to experimental defects. The measurement of the velocity of the canal-rays is considered, as is also the polarisation condition of the canal-ray light. A. E. G.

1437. *Extraction of Electrons from Metals by Intense Electric Fields.* **R. A. Millikan and C. F. Eyring.** (Phys. Rev. 27. pp. 51–67, Jan., 1926.)—To obtain a small radius of curvature and consequently an intense field, a kathode is made of tungsten wire 0·00123 cm. in diameter while the anode is a coaxial copper cylinder 1·625 cm. in diameter. These electrodes are subjected *in vacuo* to potential differences up to 12,000 volts from d.c. generators, and the current flowing across the space between them ("field current") is found to rise from 10^{-12} to 10^{-3} amps. as the voltage gradient rises from 400 to 1100 kv./cm. The current/voltage curves depend on the previous heat treatment and on the maximum ("conditioning") current previously drawn from the specimen; they are reversibly reproducible below that maximum. After being conditioned by strong heating or heavy field current the wire emits reduced field currents. Temperatures up to 700° C. have no effect, but a temperature of 800° C. multiplies the currents by a constant factor. The whole of the field current appears to be drawn from a few active spots on the wire, and it is suggested that the reduction in current caused by conditioning is due to the rounding-off of sharp points from which the electrons ordinarily escape. The fact that the field current is not a function of the temperature of the wire is held to imply that the conduction electrons do not share in thermal agitation, whereas the thermions do. C. W. H.

1438. *Propagation of Radio Waves over the Earth.* **A. H. Taylor and E. O. Hulburt.** (Phys. Rev. 27. pp. 189–215, Feb., 1926.)—A quantitative theory is developed assuming the upper atmosphere to contain free electrons and taking into account the effect of the earth's magnetic field on their motion. The formulæ for the refractive indices of radio waves in the electron layer are shown to involve a critical wave-length of 214 metres. This is significant, as the range of radio waves is a minimum at about 200 metres. The electron layer is first considered to be sharply separated from the lower atmosphere, and the waves then suffer total reflection when incident at more than the critical angle determined by Snell's law. The resulting "skip distance" is calculated as a function of wave-length, and good agreement is shown with the results of A. H. Taylor at 16, 21, 32 and 40 metres. The sharp separation is then replaced by a continuous variation in the electron density. Various laws relating density to height are assumed, and by a suitable choice of the parameters involved the observed skip distances are again obtained. The general conclusion is reached that, during full daylight, the average density of free electrons increases with the height and attains a maximum between 70 and 150 miles up. Certain well-known distortion effects, slow- and high-speed fading, are elucidated in terms of the theory assuming a motion of the electron clouds and the consequent shifting of the interference patterns. The effect on long-distance transmission of repeated reflections at the electron layer and the earth is considered.

W. S. S.

1439. *Experimental Investigation of Undamped Oscillations in Electrostatically Coupled Circuits.* **S. Morugina.** (Archiv f. Elektrot. 15. pp. 466–469, Feb. 6, 1926.)—Describes an experimental investigation of the amplitude and frequency variations of two electrostatically coupled circuits, one being a generator and the other a resonator. The theory of the arrangement used has previously been given by Tartarinow [Abstract 1447 (1923)]. With loose coupling the agreement between theory and experiment was excellent; with tight coupling between the circuits the agreement was not so good. A. W.

1440. *Electron Oscillations inside Triodes.* **S. J. Ziltinkewitsch.** (Archiv f. Elektrot. 15. pp. 470–489, Feb. 6, 1926.)—Describes work (carried out in 1921 and 1922) similar to that of Barkhausen and Kurz [Abstract 908 (1920)]. The chief interest lies in the theoretical treatment given in the latter part. A. W.

1441. *The Self-tuning Crystal.* **F. Seidl.** (Phys. Zeits. 27. pp. 64–65, Jan. 15, 1926.)—The tones occur for different parts of the crystal at different tensions, and the magnitude of the tension intervals in which the tones happen depend on the negative characteristic of the part of the crystal used. Further experiments with different materials for anode and kathode, and on the dependence of the appearances on the crystal axis and on the gas-pressure are in progress. A. E. G.

1442. *Study of the Action of a Positive-Ray Tube.* **M. Morand.** (Comptes Rendus, 182. pp. 623–625, March 8, 1926.)—Earlier work [see Abstract 595 (1926)] on positive rays in a metallic tube has been extended by examination of the positive emission in intense magnetic fields. Since the heat supply to the pointed anode is known, the electric field necessary for the tube to function can be determined. A valve of 50,000 volts/cm. was found for a temperature slightly below that of fusion of the mixture of salt used. This arrangement gives a field without complex ionisation and avoids secondary ionisation phenomena and neutralisation by collision. Any remaining emission is feeble, and halogen ions liberated by the departure of Li ions are evacuated rapidly, so that the anode is not surrounded by an atmosphere likely to produce more complex phenomena. The effects of scattering and of the presence of newly formed ions in changing the character of the emission are also investigated.

R. S. R.

1443. *Damping and Necessary Number of Members in Electric Filter Networks.* **F. Loebner.** (Archiv f. Elektrot. 15. pp. 385–407, Feb. 6, 1926.)—For three kinds of networks—namely, for inductance networks, condenser networks and networks with series condensers—Wagner has obtained a formula which gives implicitly the damping constant for each frequency ratio in each member of the network for the case of equalised end impedance. In the present paper a series of simple approximate formulæ is derived which give explicitly within certain limits the damping constant to within 1 %. A. W.

1444. *Electric Filter Networks.* **F. Loebner.** (Archiv f. Elektrot. 15. pp. 408–424, Feb. 6, 1926.)—A discussion has been given of the case of filter networks with equalised end impedance [see preceding Abstract]. The present paper deals with the case of networks with a complex end impedance, the simplifying assumption being made that the ohmic resistance within individual members of the network can be in general neglected. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1445. *On the Increase of Conductivity of Solid Dielectrics under the Influence of Röntgen-Rays.* **C. Roos.** (Zeits. f. Physik, 36. 1. pp. 18–35, 1926.)—This investigation relates to the changes of conductivity exhibited by sulphur, paraffin, ebonite and amber when subjected to Röntgen radiation. In the case of sulphur no sign of a saturation value has been indicated, whereas paraffin, ebonite, and amber afford typical saturation current curves. The radiation conductivity has been examined with respect to the hardness of the Röntgen radiation and compared with the conductivity of the air. For thin insulator layers the conductivity of sulphur is essentially greater than that of the other substances. The experiments are very fully described with numerous curves and tables of data. H. H. Ho.

1446. *Dielectric Constants of Solutions of Electrolytes.* **R. T. Lattey.** (Zeits. phys. Chem. 119. pp. 104–106, Jan., 1926.)—A reply to Walden, Ulich and Werner's criticisms [Abstract 1730 (1925)]. T. H. P.

1447. *Reply to Lattey.* **Walden, Ulich** and **Werner.** (Zeits. phys. Chem. 119. pp. 107–110, Jan., 1926.)—See preceding Abstract. T. H. P.

1448. *The Dielectric Constant and Molecular Weight of Bromine Vapour.* **L. Pauling.** (Phys. Rev. 27. pp. 181–182, Feb., 1926.)—It is shown that the conclusion reached by Bramley in a recent article [Abstract 2404 (1925)] that bromine has the formula $(Br_2)_6$ is inconsistent with previous results relating to the density of this substance in the gaseous state and that it is not theoretically justified by the considerations presented by the author. AUTHOR.

1449. *Effect of Atmospheric Humidity on Dielectric Losses in Fibrous Insulators.* **S. Setoh** and **Y. Toriyama.** (Inst. Phys. and Chem. Research, Tôkyô, Sci. Papers, 3. pp. 283–323, Jan., 1926.)—The samples investigated by the authors included manila, parchment, filter, and tracing papers; silk, horn fibre, calico, leatheroid, empire cloth, red rope paper, and manila paper soaked in transformer oil. The samples were 101·5 sq. cm. in area, and were wound on gold-plated brass cylinders 2·2 cm. in dia. and 17 cm. long. The other electrode was formed of gold-plated brass wire gauze (1000 meshes per sq. cm.) having an area of 72 sq. cm., which covered the middle portion of the sample. Ten such cylinders were suspended from a brass plate in a glass desiccator over a vessel containing sulphuric acid of the desired density, the humidity of the atmosphere being determined from the density of the acid. An electrostatic wattmeter was used for measuring the losses in the samples. Days or weeks elapsed before the materials under test reached a steady state, when the humidity of the surrounding atmosphere was changed. The authors find that when the voltage, frequency and temperature are maintained constant, the relation connecting the dielectric loss P with the percentage relative humidity H may be approximately represented by the formula

$$\log_{10} P = \log_{10} C - n \log_{10} (100 - H) + m[\log_{10} (100 - H)]^2,$$

C, m and n being constants for a given material. A hysteresis effect is observed when the humidity is first increased and then decreased. The power factor of untreated and imperfectly treated fibrous materials reaches the value of unity at about 70 to 80 % humidity at a frequency of 50. The losses are, for constant humidity, proportional to some power of the voltage, varying from 1·9 to 2·45 according to the humidity. The results obtained by the authors are exhibited in a series of curves. As regards the variations of the losses and power factor with frequency, the authors find that these may be represented by an equivalent circuit consisting of two parallel branches, one branch consisting of a resistance and the other of a resistance in series with a capacity. A. H.

1450. *Law of Variation of the Volta-Effect in Function of the Temperature.* **E. Foà.** (N. Cimento, 3. pp. 49–66, Jan.–Feb., 1926.)—The object of this paper is to put forward certain considerations based upon the second principle of thermodynamics which will lead, if certain hypotheses here given are accepted, to establishing that the Volta-effect varies proportionally to the absolute temperature. A. E. G.

1451. *Measurement of the Resistance of a Condenser at Radio Frequency.* **C. D. Callis.** (Phil. Mag. 1. pp. 428–432, Feb., 1926.)—Previous measurements of the resistance of condensers were made at low frequencies and comparative methods used to get the value at radio frequencies, this being based on the fact that dielectric losses diminish with frequency. In the present tests the resistance of a variable air-condenser with semicircular plates of the " low loss " type was measured at a frequency of 1,000,000 cycles per sec. A radio-frequency galvanometer or milliammeter is placed in the circuit of a coil and a condenser. The circuit is tuned so as to be in exact resonance with an oscillating circuit and the current noted in the meter. A known resistance is inserted and the current noted again. From these readings the resistance of the circuit is determined. The resistance of the condenser was found to vary inversely with the capacity, and is not small or zero as was supposed. R. S. R.

1452. *Detection of Small Changes in Resistance, Inductance and Capacity by Means of an Oscillating Circuit.* **L. S. Taylor.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 149–158, Feb., 1926.)—The device here discussed contains in itself no new elements, being essentially a Colpitt's oscillating circuit of carefully selected constants. Its operation rests upon the principle that under certain conditions there may be " trapped " in the grid circuit a negative charge of sufficient magnitude to cause the circuit to cease oscillating. A diagram of the circuit is given and graphs show the following: The general way in which the circuit starts oscillating after a silent interval; the effect of grid leak resistance on beat frequency; the capacity effect of grid condenser on beat frequency; the effect of inductance on the beat frequency; the effect of filament current on beat frequency. A. E. G.

1453. *A Composite Photoelectric Effect.* **A. Carrelli.** (Accad. Lincei, Atti, 3. pp. 82–87, Jan. 17, 1926.)—P. Auger has shown experimentally [see Abstract 2718 (1925)] by means of the Wilson condensation method that when the emission of secondary rays, β-rays or photoelectrons are produced in a gas by X-rays, in almost all cases a " soft " corpuscular radiation is associated with them. This paper consists of a theoretical consideration of the subject. A. E. G.

1454. *Thermoelectric Force and Hall's Coefficient.* **O. M. Corbino.** (Accad. Lincei, Atti, 2. pp. 526–530, Dec. 20, 1925.)—Discussing mathematically the divergence between theory and experiment and the recent paper by Heaps [Abstract 603 (1926)], the author finds no reason for departing from the conclusions reached in a previous paper [see Abstract 935 (1921)]. E. F.

1455. *A Double Percentage Bridge.* **A. C. Longden.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 131–134, Feb., 1926.)—This instrument is essentially a double bridge supplied with two slide wires which are used in equalising the ratio coils. The resistance of the ratio coils bears such a relation to that of the slide wires that the ratio coils may be used as the auxiliary coils in a percentage bridge. In addition to simplifying the process of equalising the ratio coils, this device offers a simple and exact method of balancing the bridge without shunting either of the standards or resorting to the rather unsatisfactory method of interpreting galvanometer deflections. Some suggestions are given concerning details of construction. AUTHOR.

1456. *Electrical Recorder.* **T. R. Harrison.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 165–172, Feb., 1926.)—A recording and automatic signalling and controlling instrument of the d'Arsonval type for use with thermocouples, radiation pyrometers, etc., is described in detail with illustrations. G. A. S.

1457. *Galena and Pyrites as Detectors.* **P. Gaubert.** (Comptes Rendus, 182. pp. 143–146, Jan. 11, 1926.)—Certain crystalline faces appear to be better than others as regards detection. Some physicists have concluded that detection is due to the distribution of the atoms in the crystals [Abstract 1962 (1925)]. On the other hand, from the list of mineral detectors given by Wherry it appears that all those which are conductors can in certain conditions rectify alternating currents. Examination of many crystals of galena and pyrites as regards the relation between the variations of crystalline form and the detecting properties has shown that the purest crystals, exhibiting the normal crystalline form, have no very sensitive points, while those exhibiting variations from the normal form usually have many sensitive points. The conclusion is drawn that the variations in form are due to impurities included in the crystals during the process of formation, and that the points of maximum rectification are found where thin layers of these impurities exist, the rectification obtained being analogous to that found by Pélabon (*ibid.*, 181. p. 776, 1925) with a very thin layer of a dielectric on a metal surface. A. W.

1458. *Apparatus for Measuring Penetrating Rays.* **W. Kolhörster.** (Phys. Zeits. 27. pp. 62–63, Jan. 15, 1926.)—The apparatus here described is illustrated with three photographs. The advantage claimed for it depends principally on its independence on the influence of temperature and pressure and on the general usefulness for all ionisation measurements, especially with penetrating rays. A. E. G.

1459. *The Electrical Counter.* **K. G. Emeléus.** (Cambridge Phil. Soc., Proc. 23. pp. 85–91, Feb., 1926.)—In a recent paper on the electrical counter [see Abstract 2342 (1925)] it was suggested that when an ionising particle enters, it brings about a momentary brush discharge from the smaller of the two electrodes, and that the transitory nature of this discharge is due to a local increase of pressure in the gas. It is now found that magnetic fields do not affect counting under certain conditions. The brush discharges from a counting point are examined with the microscope, the function of the series resistance is further studied, an approximate measurement is made of the mechanical reaction on the electrodes, an attempt is made to detect hysteresis in the discharge, with negative results, and an effect of intense ionisation is noted. A. E. G.

ALTERNATING CURRENTS AND MAGNETISM.

1460. *Reversibility of Frequency Multipliers with Iron Core.* **A. Blondel.** (Comptes Rendus, 182. pp. 297–299, Feb. 1, 1926.)—Fallou and Mauduit have shown [see next Abstract] how to produce a frequency de-multiplier by means of an induction coil with iron core, regulated by condensors on two different frequencies, such that the secondary circuit produces a current corresponding to a sub-multiple frequency of the fundamental wave of the primary circuit. An attempt is here made to demonstrate that the reversibility of a frequency multiplier, thus shown experimentally, is evident theoretically *à priori* from purely mathematical considerations. A. E. G.

1461. *Maintenance of a Free Non-sinusoidal Oscillation by Resonance of One of its Harmonics.* **J. Fallou** and **A. Mauduit.** (Comptes Rendus, 182. pp. 312–313, Feb. 1, 1926.)—If a circuit consisting of a condenser C, a self-inductance without iron L of resistance R, and an alternating source of pulsation ω, R being so chosen that resonance is possible, is closed by means of an interrupter, the tension at the terminals of the condenser comprises a damped transition term due to the free oscillation of the system of which the pulsation is approximately $m = 1/\sqrt{LC}$, and a permanent alternating term of which the pulsation is equal to that of the source. At the end of a certain time defined by the exponential factor the transitory term becomes negligible, and the term of pulsation ω subsists alone. If now a coil with magnetic core of the same coefficient of self-induction is substituted for the coil without iron, the closing of the circuit calls forth at the terminal of the condenser a tension comprising a transitory term and a permanent term. If the current developed by the transitory term is great enough to saturate the core the form of the wave of this current will be altered, and the tension at the terminals of the condenser will comprise a fundamental wave of pulsation m, accompanied by a series of harmonics [see preceding Abstract]. A. E. G.

1462. *On the Electronic Theory of Thermomagnetic Phenomena.* **O. M. Corbino.** (Accad. Lincei, Atti, 3. pp. 3–8, Jan. 3, 1926.)—Experimenting with a metallic disc heated at the centre or at the circumference and placed in a magnetic field, the author finds that only in the case of gold, silver and copper does the Lorentz-Gans theory offer a satisfactory explanation of all the thermo- and galvanomagnetic phenomena. In the case of all other metals, particularly those which, like bismuth and antimony, show these phenomena in a marked degree, there are insuperable contradictions between theory and experiment. Livens [see Abstract 1549 (1915)], developing the conceptions of Bohr and Richardson, attempted to replace the perfectly elastic shocks between electrons and atoms of the Lorentz-Gans theory by repulsive forces dependent on the distance between them. The author proposes to show in a future paper that the theory of Livens leads to still greater difficulties, as a thermal analogy of Barlow's wheel could be deduced from it, *i.e.* permanent rotation in a magnetic field of a disc traversed by a radial heat current, a phenomenon which the author has proved to be non-existent. The treatment is mathematical. E. F.

1463. *Magnetisation of Nickel and the Magneto-caloric Effect.* **P. Weiss** and **R. Forrer.** (Ann. de Physique, 15. pp. 153–213, Jan.–Feb., 1926.)—The magnetic properties of very pure nickel have been measured in various fields at different temperatures. The fields range from 2300 gauss to 21,300 gauss. The specimen in the form of a sphere is suddenly pulled out of the field and the magnetic intensity calculated from a resultant ballistic kick. The fall of temperature which occurs when the sphere is withdrawn is also measured. The results are shown in a series of magnetisation isotherms. The measurements relate to the temperature range up to 630° C., and in the region of the critical temperature they are given for intervals of 2° C. The magneto-caloric observations enable the coefficient of spontaneous magnetisation to be calculated, and they also serve to give the true magnetisation isotherms, as distinct from the apparent isotherms found experimentally. It is finally concluded that the derivation of a law governing the ferromagnetic state is impossible on the basis of the classical views of paramagnetism and upon those of the molecular field. The necessity is recognised of a revision of the fundamental postulates, and an approach is made on the basis of a statistical variation of the atomic moment. A. A. D.

1464. *Temperature Coefficient of Magnetic Permeability of Sheet Steel.* **T. Spooner.** (Phys. Rev. 27. pp. 183–188, Feb., 1926.)—The samples tested were annealed punched rings of commercial sheet steel such as is used in electrical apparatus, containing 0·9 to 4 % silicon. Temperature coefficients were determined in the range from − 20° to + 46° C. As the induction was increased from 2 to 10 kilogausses, the coefficient decreased from + 0·12 % per 1° C. to − 0·021 % for 0·9 % Si, from + 0·08 % to − 0·08 % for 2·2 % Si, and from − 0·03 % to − 0·18 % for 4 % Si. Each curve showed a minimum at 10 kilogausses, although the maximum permeability normally occurs at 6 to 8 kilogausses. This minimum corresponds to 2 gilberts per cm., and is sharper the higher the Si content. These results indicate that the temperature coefficient is more directly related to the induction than to the permeability. AUTHOR.

1465. *The Force between Two Magnetised Spheres.* **G. W. Brydon, A. Elliott** and **R. G. Lunnon.** (Univ. of Durham Phil. Soc., Proc. 7. 2. pp. 59–66, 1924–1925.)—In experiments described by King [Abstract 634 (1923)] the force of repulsion between magnetised spheres is displayed. An attempt is made both practically and theoretically in the present paper to find the relation between the force F and the distance between the spheres (x). It is found that $F = kx^{-n}$ where $n = 3{\cdot}66 \pm 0{\cdot}10$. By a second more accurate method, using a torsion balance, the value of n is found to be 3·7 as a mean value. Theoretical considerations do not lead to a satisfactory deduction of the experimental formula. W. V. M.

1466. *Magnetic Susceptibility of Binary Alloys and the Equilibrium Diagram.* **H. Endo.** (Tôhoku Univ., Sci. Reports, 14. pp. 479–512, Dec., 1925. Report No. 109 from the Research Inst. for Iron, Steel and other Metals.)—The following alloys were examined magnetically by means of a modification of Weiss's method: Cu-Sn, Cu-Zn, Bi-Sn, Zn-Sn, Pb-Tl, Bi-Pb, Sb-Sn, Sb-Cu, Bi-Zn, Sb-Pb, Bi-Te, and Cu-Mn. It was found that each compound has a susceptibility characteristic of it. When the alloys consist of a mechanical mixture of two constituents, the susceptibility concentration graph is a straight line; when the constituents form a solid solution, the graph is curved. If a small amount of an element is dissolved in a strong diamagnetic element, such as Bi or Sb, the susceptibility of the latter increases to the concentration of the solubility limit. Equilibrium diagrams for Bi-Sn, Sb-Pb, and Bi-Te were revised on the basis of the magnetic analysis. G. E. A.

1467. *The Effect of Hydrostatic Pressure on the Magnetic Permeability of Iron, Cobalt and Nickel.* **Chi-Sun Yeh.** (Am. Acad., Proc. 60. pp. 503–533, Dec., 1925.)—(1) Within the pressure range 0–12,000 kg./cm.^{2}, the change of magnetisation at constant H is linear with pressure for iron, cobalt and nickel. (2) Within the field range 0–100 gauss, the pressure coefficient of magnetisation per unit volume is negative for iron, but positive for nickel. It is highly probable on experimental grounds that the sign of the coefficient will not reverse for higher fields. (3) For cobalt, the pressure coefficient of magnetisation per unit volume is negative for fields below about 30 gausses, but positive for higher fields. (4) For pure iron at room-temperature, the percentage change of magnetisation has a maximum of $- 5{\cdot}5$ % per 1000 kg./cm.^{2} at H about 1·2. The percentage change decreases rapidly on both sides of this maximum approaching the axis asymptotically for large H. Such a maximum change also exists for nickel, of value $+ 4{\cdot}5$ % per 1000 kg./cm.^{2} at $H = 1{\cdot}3$. (5) For both pure iron and nickel (except nickel in very low fields), the absolute value of the pressure change of magnetisation per unit volume is less at a higher temperature. (6) For iron, the percentage change of magnetisation is a very sensitive function of its carbon content. (7) The retentivity of iron decreases under pressure. (8) By simple thermodynamics it is shown that the volume change produced by magnetisation can be analysed into two terms; the term involving the pressure coefficient of magnetisation is important at low fields, while the other term not involving the pressure coefficient becomes increasingly important at high fields. W. V. M.

1468. *A Study of the Correlation of the Remanent Magnetism and Specific Resistance of Some Pure Iron-Carbon Alloys.* **E. D. Campbell.**

(Faraday Soc., Trans. 21. pp. 338–348, Dec., 1925.)—The remanent magnetism of a series of rods with carbon content ranging up to 1·5 % has been examined by means of a special form of magnetic balance. In this instrument the attraction force is measured between the rod under test and a standard rod of iron in a solenoid carrying a known current. The rods were tested in the annealed, hardened and tempered states. The specific resistance of the rods was determined by the usual fall of potential method. The results are correlated on the assumption that the carbide has a high and the iron a low magneto-motive potential. A. A. D.

1469. *Self-magnetisation of Steels in Torsion.* **R. Cazaud.** (Comptes Rendus, 182. pp. 467–468, Feb. 15, 1926.)—Cylindrical steel test bars are subjected to varying torsion and a constant tension in a magnetic field produced by a primary winding carrying a steady current, and surrounded by one secondary winding connected with a galvanometer and another with a Grassot fluxmeter. The steels tested contain from 0·3 % to 1·0 % C. Up to 0·5 % C. the flux-variation is negative, higher carbon content giving positive values. For extra hard steels, quenched steels and steels of martensitic structure the variation of flux with torsional deformation is continuous and positive. Release of torsion produces a flux of the same sense as that produced by torsion, the steel tending to a state of magnetic saturation under the effect of repeated torsions. It is suggested that a rapid method of determination of the composition and thermal treatment of steels might be based on the study of the magnetic effects of torsion described. A. B. C. L.

1470. *Further Note on Magnetic Screening of Galvanometers.* **D. W. Dye.** (Journ. Sci. Instruments, 3. pp. 141–143, Feb., 1926.)—In a previous paper [Abstract 863 (1926)] the use of stalloy ring stampings for the screening of galvanometers was considered, and in the calculations a value of 400 was taken for the permeability of this material. It was pointed out by a critic that permalloy with a value for μ of 30,000 would give the same effective screening for very much less material. In the present note it is shown that a value of $\mu = 4000$ is the best value that can be expected from permalloy in view of the nature of the problem. This still, of course, gives this material a great advantage over stalloy, but not as much as was suggested. A. A. D.

1471. *A New Variometer for the Comparison of Horizontal Magnetic Fields.* **E. Brammer.** (Zeits. Instrumentenk. 45. pp. 576–579, Dec., 1925.)—Two very light magnets are pivoted one above the other. Between them and parallel to them is an adjustable permanent magnet. This permanent magnet is so placed that on the upper needle the earth's field is slightly over-compensated, and on the lower needle slightly under-compensated, and to the same amount. Thus, when the instrument is set in the meridian the upper needle is reversed. If now the controlling magnet is swung out of the meridian by a measured amount the needles set themselves at equal and opposite angles to it. These angles depend on the strength of the earth's field. A diagram and full details of the instrument are given, together with a discussion of its sensitivity. A. A. D.

1472. *The Compass-variometer.* **L. A. Bauer, W. J. Peters** and **J. A. Fleming.** (Dept. of Terrest. Magnetism, Researches, 5. pp. 339–357, Jan., 1926.)—Compass-variometers have been designed for the investigation of local magnetic disturbances, the detection of effects caused by hidden magnetic objects or materials and for registering intensity variations with high precision. In principle the instrument has two magnets of equal magnetic moment suspended independently one above the other and mounted so that the distance between them may be varied to maintain a fixed horizontal deflection angle for a particular, but not necessarily known, intensity of field. The magnets adopted were of the disc type made of very thin magnet steel magnetised in coils along fixed diameters and artificially aged, thus obtaining constant magnetic moments. Four types of compass are explained in detail, and the relative advantages of each examined. For use at sea precautions were taken to avoid difficulties caused by changes of the ship's magnetism, dynamical effects of the sea, and to procure ease of manipulation. The theory underlying the method is explained, and examples are given of results obtained in a magnetic survey of a dock and of a part of Bermuda where a magnetic anomaly was investigated in detail. R. S. R.

1473. *The Origin of the Earth's Electric and Magnetic Phenomena.* **W. F. G. Swann.** (Frank. Inst., J. 201. pp. 143–176, Feb., 1926.)—The various theories advanced to account for the earth's electric and magnetic fields are outlined and reasons given why they are all to be considered inadequate. A new view is outlined which depends on a modification of the laws of electrodynamics. Two terms are added to the current density in the field equations for positive electricity, the equations for negative electricity being left unchanged. For the magnitudes involved in the earth's motion, these terms amount at most to one part in 10^{26} and five parts in 10^{19} of the main term. This modification provides for the correct value for the part of the magnetic field of the earth which is symmetrical about the axis of rotation. Further, the modification provides for a slow death of positive electricity, on account of rotation, a death amounting to the disappearance of one-two hundredth of the earth's charge in 10^{14} years. In the corresponding surplus of negative electricity freed by this process the atmospheric electric current and the atmospheric potential gradient are provided for. In addition, the law of force between like and unlike charges has been modified along the lines of the theory of Lorentz in such a way as to provide for gravitation. The whole scheme of equations is consistent with the requirements of both the restricted and general theory of relativity. A. A. D.

1474. *Magnetic Results obtained aboard the "Carnegie,"* 1915–1921. **J. P. Ault** and **S. J. Mauchly.** (Dept. of Terrest. Magnetism, Researches, 5. pp. 3–286, Jan., 1926.)

1475. *The Hudson Bay Expedition,* 1914. **W. J. Peters.** (Dept. of Terrest. Magnetism, Researches, 5. pp. 289–313, Jan., 1926.)

1476. *On a Period of Approximately* 9·2 *Years in the Greenwich Observations of Magnetic Declination and Horizontal Force.* **H. H. Turner.** (Roy. Astron. Soc., M.N. 86. pp. 108–118, Jan., 1926.)—Magnetic observations of ranges of declination and horizontal force at Greenwich, for the years 1841 to 1904, show periodic variations in 9·26 years. This period cannot be assigned with very great accuracy owing to the interference of the sunspot period of 23 years with its second and third harmonics, the former being usually recognised as the chief cycle. The coefficient in range of declination is about 0′·4; and in range of horizontal force about $12y$. The coefficients a_1 and b_1 in the expressions calculated for harmonic variation in the Greenwich volumes also show this 9·2-year period, and are similarly perturbed by the 23-year period and its harmonics. Apparently this 9·2-year period is not represented in sunspots, and should have some other origin. It may be connected with the revolution of the moon's nodes. A. A. D.

1477. *Unsuccessful Search for the 9·2-year Magnetic Period in Sunspot Records and New Analysis of Records back to* 1610. **H. H. Turner.** (Roy. Astron. Soc., M.N. 86. pp. 119–130, Jan., 1926.)—In a previous paper [see preceding Abstract] evidence is adduced for the existence of a periodicity of 9·2 years in magnetic elements. The following is a summary of the present paper: Search for the 9·2-year magnetic period in the sunspot variation has resulted in failure to detect it. To leave no stone unturned, Wolfer's early records of maxima and minima (from 1610 onwards) were examined. These show clearly two periodicities, one of 11·2 years and one of 8·75 years (Table V), up to about 1750, when we have the Wolf numbers. Apparently there was a definite change about this time. Instead of the 8·75-year term, which drops out or becomes very small, we get a 9·96-year period. But more clearly still is shown a 13-year period, which seems to fluctuate. The fluctuation of the 13-year period is best shown by the long series from 1610, for apparently it existed from that date, though its coefficient was small. It was much enhanced about 1728, and was thus more easily found in the later observations. The fluctuation takes place in 130 years. After removing this fluctuating term, we get a good value for the 11-year period as 67/6 years, confirmed by the long series. Further, the difference between consecutive 11-year cycles (which may be connected with the reversal of magnetic polarity at minimum) is now rendered systematic, whereas on the supposition of an 11·5-year period (suggested by observations from 1880 for which we have the Greenwich measures) this alternation is much less clearly shown. These results represent a view of sunspot periodicity quite different from that worked out in M.N. 74, 82. The fluctuations were there ascribed to a single swarm of meteors with a variable orbit. The present treatment would correspond to a combination of several swarms. But both treatments suggest epochs of discontinuity and the examination of the early records from 1610 to 1750 has suggested a new one, 1734, which accords with those previously noticed in being near a return of the Leonids. No preference is at present suggested for this later analysis over the former. It was undertaken with the quite definite and different object of tracing some origin for the magnetic period, which has completely failed; and for the present the matter must be left there. G. W. de T.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

1478. *Healing of Lesions Caused by X-Rays by means of Diathermy Coagulation.* **X. Debédat.** (Rev. Gén. d'Él. 19. pp. 372–373, March 6, 1926.)—The author illustrates, by means of photographs, the cure of epitheliomatous growths upon the fingers due to X-rays. These were treated by diathermic coagulation, with remarkable curative results, particularly when the resistance nature of these growths to other methods of treatment is remembered. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY

1479. *Absorption of Hydrogen in Potassium Vapour Arcs.* **R. D. Rusk.** (Phil. Mag. 1. pp. 97–109, Jan., 1926.)—The absorption of hydrogen by hot potassium vapour, which is accelerated by an electric discharge, is found to be accelerated also by the action of a low-voltage arc formed between a coated platinum filament and an anode. The rate of absorption for pressures of the order of a millimetre is found by measuring the variations in pressure, and the effect of varying the voltage and the temperature is studied. It is found that the arc has no effect below an arc voltage of 16 volts. For a given voltage and temperature the rate of absorption is substantially constant at the beginning of the absorption, and when the rates are plotted against voltages the curve rises rapidly from zero at 16 volts. The rate is roughly proportional to the vapour density of the potassium, and rises with temperature to a maximum at 190° C.; at higher temperatures the dissociation pressure of KH becomes effective. The results are consistent with the view that 16 volts is the critical voltage for the production of molecules so excited that on collision they dissociate into atoms of which half are ionised. C. W. H.

1480. *The Adsorption of Gases by Activated Charcoal at Very Low Pressures.* **H. Rowe.** (Phil. Mag. 1. pp. 109–131, Jan., 1926.)—Experiments are carried out at air-temperature with CO_2, N_2, O_2, and CO, with the object of testing equations connecting the total quantity of gas adsorbed with pressure, and devised by Freundlich, A. M. Williams, and Langmuir respectively. Small measured volumes of the gas under observation are admitted successively to an apparatus containing activated coconut charcoal, the same sample being used for the first three of the above gases and outgassed before each experiment. After each admission of gas the pressure is observed when equilibrium has been re-established, the pressures ranging from 10^{-5} to 10^{-1} mm. The results are plotted so as to test the following formulæ: Freundlich, $q = kp^{1/n}$; A. M. Williams, $q = p \,.\, k \,.\, e^{-A_1 q}$; Langmuir, $\log a/p = \log A - A_1 a$; where q = total N.T.P. volume of gas adsorbed, a = number of gram molecules adsorbed, p = pressure, and the remaining quantities are constants. It is found that the last two equations, which are of equivalent form, more nearly represent the experimental results than does the first. At very low pressures they become approximately linear equations, the linearity ceasing at a pressure which depends on the boiling-point of the gas. C. W. H.

1481. *Adsorption of Carbon Dioxide by Activated Coconut Charcoal.* **H. Rowe.** (Phil. Mag. 1. pp. 659–670, March, 1926.)—The author determines the rate of diminution in the pressure observed when CO_2, at initial pressures ranging from 2×10^{-2} to $1 \cdot 5 \times 10^{-1}$ mm., is being adsorbed by charcoal at 20° or 15° C. When the initial pressure is small, the rate of fall is rapid during the first fifteen minutes or less, and very slow during the subsequent twenty-four hours. When the charcoal is not perfectly outgassed to start with, the adsorption is more gradual. It would appear, then, that the first, almost instantaneous, adsorption cannot, except at very low initial pressures, be separated from the more gradual adsorption.

But the phenomena are too complex, and experimental conditions would have to be simplified before any theory can be advanced. The experimental arrangements were as in the preceding Abstract. H. B.

1482. *Verification of Gibb's Adsorption Equation and its Bearing on Nernst's Theory of Electrode Potential.* **R. K. Schofield.** (Phil. Mag. 1. pp. 641–658, March, 1926.)—Patrick's "constant-flow" adsorption tube (Zeits. phys. Chem. 86. p. 545, 1914) is modified so that a dilute oxygen-free solution of sulphuric acid containing mercurous sulphate and sodium sulphate is driven in a divided stream, one part A flowing past the mercury dropping jet and the other B over the surface into which the drops coalesce at the bottom of the adsorption tube. The deficit of mercurous ions in A and the excess in B over the initial concentration in the acid stream are measured potentiometrically. For solutions of the same composition, measurements on B show that the rate of production of mercurous ions is proportional to the rate of disappearance of drop surface, and is independent of the flow rate: the rate of removal of ions in A by the equally rapid formation of drop surface at the jet is always slower. This discrepancy is greater the faster the drop rate and the slower the flow rate, and is due to the fact that oxygen-free sulphuric acid attacks chemically a moving mercury surface. The values of Γ electron given by Gibb's adsorption equation $d\sigma = -\Sigma\Gamma d\mu$, or by Lippmann's modification $d\sigma/d\Delta = \epsilon \times 10^7$ are measured for the solutions used in the preceding experiments by a capillary electrometer, and for those solutions more concentrated in mercurous sulphate, good agreement is obtained with the values measured directly by the mercury-drop method. The drop method gives a quantitative measure of the "ionic transfer" postulated by Nernst's theory of electrode potential. L. M. C.

1483. *Absorption of Gases by Colloidal Solutions.* **A. Gatterer.** (Chem. Soc., J. pp. 299–316, Feb., 1926.)—Colloidal solutions of ferric hydroxide and Prussian-blue behave very differently towards carbon dioxide and acetylene. The solubility of carbon dioxide in the more concentrated solutions of ferric hydroxide exceeds its solubility in water by as much as 20 %, and is almost directly proportional to the concentration of the sol [see Findlay and others, Abstracts 1167 (1910), 1778 (1912), 1370 (1913), 1631 (1914)]. Carbon dioxide is moderately more soluble (3 or 4 % at most) in solutions of Prussian-blue than in water, the solubility showing a well-defined maximum at all temperatures for a concentration 0·3 normal. Acetylene, however, is less soluble in either of these colloidal solutions than in water. These and other regularities in the solubility are discussed in relation to the chemical nature of the colloid and of the gas absorbed (chemical combination), the influence of the specific surface (adsorption), the nature of the electric change and the temperature.

T. H. P.

1484. *Adsorption of Ethylene and Hydrogen by Zinc Oxide, Iron Oxide, Nickel and Copper.* **W. A. Lazier** and **H. Adkins.** (J. Phys. Chem. 30. pp. 353–358, March, 1926.)—The volumes of hydrogen and of ethylene adsorbed by copper, nickel, zinc oxide and iron oxide at ordinary temperatures are found to depend on the method of preparation and the purity of the adsorbing agent. For example, 100-gm. samples of nickel obtained by reduction of the oxide with hydrogen and with alcohol adsorb respectively 70 c.c. and 205 c.c. of ethylene, while like amounts of pure copper and copper containing nickel (1 %) take up 0·55 c.c. and 24 c.c. of hydrogen. Reduction of ethylene with hydrogen is shown to be promoted by these catalytic agents, and there is qualitative agreement between the volume of gas they adsorb and their catalytic activity in promoting reaction between ethylene and hydrogen. When equimolecular mixtures of these two gases react in the presence of "degased" nickel, the "induction" period, which is observed when ethylene is admitted to nickel saturated with hydrogen, is no longer apparent. L. M. C.

1485. *Equilibrium in Colloid Systems.* **O. K. Rice.** (J. Phys. Chem. 30. pp. 189–204, Feb., 1926.)—A generalised phase rule is developed in a form in which it can be applied to electrically-charged colloids. The components are defined by the dispersed phase, the dispersion medium, electronic charge and dissolved salt, and the variants are the relative amounts of colloid, solvent and salt, temperature, size of particle, internal pressure (surface-tension), and external pressure. The dynamics of the different cases are considered with especial regard to the criterion of stability. It is inferred that both where the particles are electrically charged and where they are not that equilibrium exists only if the particles are all of one size, or of a few definite sizes. The conditions for stability, of which two distinct types, temporary and permanent, are found, are considered in detail [see Abstract 457 (1925)]. J. N. P.

1486. *The Apparent Viscosity of Solutions of Nitro Cotton in Various Solvents.* **J. W. McBain, C. E. Harvey** and **L. E. Smith.** (J. Phys. Chem. 30. pp. 312–352, March, 1926.)—In an investigation of the solubility of nitro-cellulose, of 12·10 nitrogen content, in organic solvents, the fluidity is taken as the criterion of solvent power. Viscosity measurements of the sols are made in an Ostwald type of viscometer. The results are regarded only as apparent values in that no account is taken of the rate of shear. A preliminary heating of the nitro cotton at 60° C. for a few hours causes an increase in viscosity, but further heating causes the viscosity to become progressively less. Vigorous shaking of freshly prepared solution diminishes the viscosity apparently by assisting in breaking down residual structures. The available information with regard to mixtures of liquids, whether solvents or non-solvents, is reviewed and extended, and it is shown that in the large majority of cases a mixture in suitable proportions is a better solvent than the individual ingredients. Similarly the solvent power of a given material is greatly dependent upon adventitious impurities; the purer sample in general being the least efficient solvent. This property is explained by assuming that certain molecular groupings in each substance have a specific power of combining with definite groupings in the nitro-cellulose complex differing from substance to substance. The apparent viscosity of the solutions is almost entirely due to the presence of loose ramifying aggregates of colloidal particles united by local and specific bonds of residual affinity of different kinds and degrees. The best solvents are those which most effectively combine with these bonds, and by themselves satisfying the residual affinities dismember the aggregates. J. N. P.